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The Dangerous Shingle Roof

A RECENT magazine note relates that one of the newspapers of Montgomery, Ala., the day after a fire which destroyed \$75,000 worth of property, damaging eleven dwellings, all of which took fire through the shingle roofs, carried immediately beneath the account of the fire this advertisement: "If you contemplate reshingling your house, see us. Building Supply Company." No comment was added and none was necessary. But even in the far more serious fire at Salem recently the lesson of the danger of the wooden-shingle roof was not thoroughly learned, for within two days after the disaster wooden shingles were being delivered about the city. Engineers, of course, have little control in their private practice over the use of shingles. Their influence can be best exercised by urging that building codes prohibit the use of such material, or require that it be fireproofed. Certainly the wooden shingle is a relic of a past age in building construction.

Revision of Road Laws

GENERAL and hearty support should be accorded to the work of the joint committee of the American Bar Association and the American Highway Association that is summarized in the article by J. E. Pennybacker on another page of this issue. The committee is going at its work in a manner that promises results. The mere compilation of the mass of State highway laws will do good, for we must first have our errors placed horridly before us before we correct them. Although the program which Mr. Pennybacker summarizes is sufficiently comprehensive to keep the committee busy for several years to come, there is a line of activity that may well be, if it is not already, comprised in the committee's program. It is stated that it will attempt the preparation and submission of constructive legislation to cover those needs of the States which have never been reached by legislation and to endeavor to harmonize and correlate the laws of various States. Incidental to this the committee might very well carry on a campaign against foolish legislation and highway-commission regulations. Education in the matter of financing road improvement is also sadly needed, and it is to be hoped that this subject will be included in the program of the committee.

Convict Labor

ANY self-respecting yeggman cannot be expected to take orders from a retired murderer. It is beneath his dignity and he simply won't do it. Now, the murderer re-

ferred to may be the only man out of sixty who knows anything about running an engine, and you may need a man to run your industrial locomotive on your road job. So what are you going to do? You can't fire your men and you can't punish them, and, furthermore, they are not responsible to you but to somebody else. Of course the slight fact that they are working for you ought to be taken into consideration. In other words, where convict labor is employed one convict will not take orders from another, and as the man in charge of the work is not the warden in legal charge of the men, conflict in authority is likely to occur. This is somewhat the condition that a representative of this journal found in visiting the State highway at Beecher, Ill., referred to elsewhere in this issue. The first difficulty lies in the convict himself and is not easily remedied, but the latter—conflict of authority—could be solved in two ways, the ideal method being that in which the engineer in charge of the work is given complete charge of the men by the prison authorities. The second method—that of close co-operation between the engineer and the prison representative in charge of the men—calls for diplomacy and extremely friendly relations between men of two radically different types. These problems, however, are but incidents in the development of a new enterprise. The advantages of using prison labor are so many that the little difficulties are sure to yield in time to careful study and mutual sympathy between road builders and prison wardens.

Enlarging One's Civic Perspective

SHORTLY after the Dayton flood of last year there was organized in that city the Greater Dayton Association, devoted to the advancement of the city in every way possible. It has been most active and has set on foot and encouraged a great number of valuable civic enterprises. Not the least of its achievements has been the awakening of a civic esprit de corps, by presenting the citizens in a weekly bulletin with data upon the progress of the various civic activities. In a recent copy of the bulletin the suggestion is made that those going out of town on their vacations should endeavor to enlarge their civic perspectives by observing the conditions in cities which they visit. The article points out that no special task need be made of the work, but that in the course of one's travels notes should be made of particulars in which the town visited seems to surpass the city of one's residence. It suggests that the condition of the streets, as to pavements and cleanliness, should be noted, that the handling of traffic, street-car accommodations, street signs, bill boards, overhead

wires, shade trees, sidewalk openings and other obstructions, parks and playgrounds, street lighting, smoke nuisance, fire-preventive measures, etc., be observed. It is requested that on return to Dayton improvements over Dayton's methods which have been observed be communicated to the Greater Dayton Association or to city officials. The suggestion is an excellent one. If followed out, it should redound to the benefit of the town whose citizens are sufficiently interested to make these observations. The chief benefit may not come from the improvements or supposed improvements suggested, but from the more intimate knowledge of city management which the observer will acquire. Deep interest in a subject is but the forerunner to active participation in movements to better conditions. Surely the cause of civic improvement would make rapid strides if the co-operation suggested is secured. The thought is well worth passing around to other communities—particularly to those of two hundred thousand population and under, in which municipal departments and civic activities are not so highly developed as to be, to the ordinary citizen, a non-understandable maze of organization.

Wastefulness in Advertising

PRODUCTS of any kind take their standing largely from the reputations of those who produce or stand back of them. The product bearing no label is burdened with a great initial handicap. The same is true of the printed word. The anonymous letter at once excites distrust and the propaganda of hidden authorship is a destroyer of confidence. It is surprising, therefore, to find that certain advertisers, generally accredited as shrewd judges of human nature, should disregard these facts in an attempt to secure a market for their product. There has been issued recently an illustrated pamphlet on the advantages of hard-surfaced roads over the ordinary dirt or macadam construction. It contains information intended to be convincing to the farmer—costs of hauling over good and bad roads, costs of construction and maintenance, and data from bulletins of the U. S. Department of Agriculture—but there is no definite statement as to the authorship of the pamphlet. The only clue is in the captions to some of the photographs, which contain the trade name of a type of surfacing controlled by an Eastern firm. This, in the opinion of the Engineering Record, is poor advertising. The first question any thinking man will ask is: "Who is making these statements?" And the answer is not forthcoming. It must not be inferred from this that the arguments in the pamphlet are unsound or the data inaccurate. Objection

is made only to the omission of the source of the information. If the facts are worth anything someone should stand behind them. Advertising literature such as this makes the reader suspicious and consequently defeats the very purpose for which it is distributed. Apparently the plea for the hard-surfaced roads is an unbiased one, while the motive is evident to anyone who reads between the lines.

Reclamation Service Appropriations

A RADICAL change in making appropriations for the U. S. Reclamation Service will be brought about if an amendment to the bill which extends the time for payment for water rights is accepted by the Senate and becomes law. The measure, with the amendment attached, passed the House without a roll call on July 30. This amendment provides that all expenditures for irrigation work must be made according to annual appropriations by Congress, which will also designate what projects are to be taken up. The amendment was written on the recommendation of the majority of a subcommittee of the committee on appropriations, headed by Congressman Borland, of Missouri. The effect of this law will be to place Reclamation Service enactments more or less on a par with the river and harbor bill, since it will fall upon Congress to determine what projects are to be built and to designate the sum to be spent on each annually.

Sufficient evidence has been brought against the river and harbor bill and its companion measure, the public buildings bill, to make any extended protest against this method of appropriation entirely unnecessary. It is a move in the direction of another Congressional "pork barrel." The reason for writing the amendment is largely that the cost of certain projects has been increased in excess of the original estimate. As is well known to readers of the Engineering Record, this is due to the extension of the works originally planned, to satisfy the demands of the settlers. Readers especially interested in the Reclamation Service will find in a "Synopsis of Hearings" of the subcommittee which drafted the amendment a clear statement of the case. The Engineering Record believes that right-minded men will agree with the conclusions of the minority rather than of the majority. Nevertheless, the amendment is tacked on to an Administration measure and doubtless will prevail. While no one will deny that Congress is entitled to the fullest information regarding the purposes for which money which it has appropriated has been spent, twelve years' experience with the Reclamation Service indicates that the present method of handling its affairs has given satisfaction. Most of the criticism against the Service is based upon the difficulty of securing the right kind of settlers for the projects, but this difficulty has been equally shared by the private projects, so that it cannot be laid to any special method of administering the affairs of the Reclamation Service.

Developing the Full Capacity of the Queensboro Bridge

RAPID development and the radical changes in the urban transportation problem of Greater New York are the most important elements affecting the service of the great East River bridges. The structure receiving most consideration at present is the Queensboro Bridge. The conditions have changed so much that the costly structure must now be modified to serve quite different requirements than those originally contemplated when it was designed about 15 years ago. It was then intended to carry four elevated-railroad and four electric surface-car tracks, vehicular traffic and pedestrians. When opened to traffic, only the surface-car tracks and the roadway platforms were installed on the lower deck, making no use of the upper deck, excepting for the temporary location of the sidewalk platforms. Later there was considerable discussion as to the adequacy of the structure for the maximum theoretical load, although it is practically impossible to impose it.

The bridge in its present condition makes no provision for connections to the elevated and subway tracks, so that, in order to utilize it for the enlarged rapid-transit scheme now under way, plans were submitted last year for a rearrangement of track floors and roadway platforms and for the construction of a new trolley-car terminal and subway-track connection at the Manhattan end, involving an estimated total cost of \$4,249,000. These plans were seriously objected to on account of the changes in the roadway facilities, which it was believed would be seriously impaired.

New plans, described on page 183, have just been approved which overcome this objection—by substituting two unobstructed roadways, each 26 ft. wide, for the present 52-ft. roadway, which is obstructed by two surface-car tracks. The benefits of this arrangement are increased by the fact that one of the roadways, on the upper deck, can be advantageously devoted to fast-moving automobiles, while that on the lower deck can be used by slower vehicles, abundant room being provided in both cases for three vehicles abreast, thus affording capacity much in excess of the present traffic. Under a block-signal system the subway and elevated-railroad trains can be operated at the rate of forty-one trains per track per hour at short intervals, and correct relative distance positions can be maintained. In this way the service can be greatly increased and the potential strength of a costly bridge can be fully utilized.

The installation of tracks connected to the lines in Manhattan and Queens will be of great value to both boroughs and may be considered as solving for the present a large part of the Queens rapid-transit problem. The service thus provided can be made adequate for years to come without interrupting the present traffic, and at a cost far less than would be involved by the construction of a proposed new subway tunnel at this point. It will thus save the difference in cost, interest, and mainte-

nance charges, without prejudice to the possible construction of tunnels to provide additional transit facilities if these become necessary.

Dilution and Sewage Treatment

A GIVEN sum of money can, in general, be spent to the greater sanitary advantage of communities by the purification of water supplies rather than by the treatment of sewage. There are a great many arguments that may be given in support of this statement, but the important ones are so simple and so well known and convincing that there is no need of repeating them here. This statement cannot be taken to exclude sewage treatment altogether, as there are, of course, many cases where large expenditures for this are entirely justified; and it may perhaps be said, too, that there are only a few places where some expenditure for sewage treatment could not be made with advantage. It would seem as though the field of sewage treatment included the prevention of local nuisance and of excessive pollution, but not, if the economic side be considered, the protection of surface-water supplies from small amounts of pollution.

A view now generally accepted looks upon dilution as an entirely reasonable and safe method of disposal so long as the dilution is great enough to prevent local nuisance. Undoubtedly dilution is a great natural resource for the disposal of sewage and other wastes, and there is every reason for making use of it so long as this use does not result in a menace to the public health, or to reasonable standards of cleanliness. Quite a number of the States have undertaken to control these matters, and their policies are generally in line with the reasonable stand that economy must be considered as well as public health and cleanliness. There may be many States where the density of population is not great, in which no special control is likely to be exercised for a long time to come, as there is no particular need of it.

The need of some such control, or at least some understanding between the two Governments, has during the last few years been realized in regard to the pollution of certain of the boundary waters between the United States and Canada. An International Joint Commission has been at work during the last few years making an investigation of the pollution of the Great Lakes and connecting waters with a view to bringing about such an understanding. The commission has made extensive investigations of the bacteriological condition of the boundary waters at various important points and has done much other work that will be of great value in arriving at an understanding.

The question of standards of water purification and sewage treatment came up before the commission some time ago, and the importance of the question was deemed great enough to warrant the commission in seeking the advice of a number of prominent sanitary engineers. A list of questions was submitted to them and consid-

ered and discussed at length. As a result a report was presented to the International Joint Commission giving, in the view of these engineers, the most reasonable answers that they could subscribe to for the various questions. This statement, published in this journal Aug. 1, page 128, is of importance to engineers and others interested in sanitary questions, as it is the most comprehensive and complete statement of general policy on this subject that has been presented on this side of the water, and takes fully into account the economical side of the question as well as the interests of the public health.

There was one dissenter who objected to certain of the paragraphs and who declined to sign the statement so long as those paragraphs were included. The grounds for his objections seemed to be, in substance, that those paragraphs provided for too generous a use of the natural resources of dilution, required too little in the way of sewage treatment where only moderate pollution was involved, and gave substantial weight to the question of reasonable economy. The dissenter appears to belong to the group—among which many members of the medical fraternity are most ardent advocates—who hold the view, with some disregard for economy, that all sewage and wastes should be treated. As an idealistic view this is most excellent, but it is rare that a community, in taking up the consideration of a question of this sort, does not have to give painstaking consideration to the cost. The lack of approval of this one member does not, therefore, lessen the force and value of the statements of the board of sanitary engineers.

The statements are all pertinent and valuable, but certain points expressed or implied appear to be of primary and unusual importance. They can be briefly stated as follows:

1. In general, all surface water to be used for public supply should be purified.
2. A step is taken toward the establishment of a policy intended to prevent the discharge into boundary waters of any sewage without at least a simple treatment, such as sedimentation or screening.
3. The adequate dilution of a sewage is a highly satisfactory means of disposal, and utilizes an important and economical natural resource.
4. The settling of the suspended matters by gravity in suitably designed tanks, or even the efficient screening of the sewage, is recognized as an important fundamental treatment.
5. The propriety of considering reasonable economy in the working out of such problems as these is established.

While the deliberations of the commission refer specifically to matters connected with the pollution of international boundary waters, the statements of the board of engineers may in a large way be applied to all bodies of water where sanitary questions are involved. The statements commend themselves to all who have to deal with questions of public health and public cleanliness.

Limitations of Commercial Engineering

IN a broad sense all engineering is commercial in character, but colloquially commercial engineering embraces that branch of the profession which is associated with the marketing of industrial products along technical lines. A striking development has taken place in this field during the last twenty years, and in innumerable instances purchasers of equipment and builders of plants have come to rely upon the advice of commercial engineers in carrying forward their enterprises. The limitations of commercial engineering, however, are often serious handicaps to the fullest success of industrial projects. Seldom have they been so well set forth as in a paper by Andrews Allen upon "Engineering Opportunities in Coal Mining," recently presented before the Western Society of Engineers. The author's conclusions are of general application.

When development or construction work is handled in connection with industrial plants by so-called engineering manufacturers under the supervision of the owner on the "free engineering-service" basis, the combination does not, as a rule, tend toward a broad and comprehensive foresight covering future development or even toward a well-balanced and mechanically efficient installation. In most cases recourse to an independent engineer tends to increase the output and life of the plant, to provide an installation more closely adapted to the requirements as a whole, to insure more economical operation, reduced fixed charges and better satisfaction per dollar expended. Given the required competence, it makes little difference whether the engineer in charge is a salaried employee of the owner or in independent professional practice. The manufacturer is enabled to give better service when he is relieved of general responsibility and can devote himself to doing his own work under definite conditions and intelligent direction.

Independent engineering conserves the value of the product by superior preparation and elastic arrangement, taking into account all the elements which make up the plant, through powers of broad analysis and constructive reasoning which the commercial engineer, working in a more limited field, rarely is able to exercise. In much commercial engineering economic waste exists. A manufacturing plant makes its profit by efficient production, and to stay in business it must ultimately establish a selling basis in fair ratio to the cost of its goods. Where such concerns employ a high-priced engineering organization to furnish services for which they are not directly paid, not only is the result essentially unfair—for the customer pays for the engineering expense of from three to ten others—but the manufacturing efficiency of the establishment is often reduced, because so much of the energy of its best men is diverted from the perfection of product and processes. The tendency in such cases to adhere to existing designs, patterns, machine tools and dies militates against well-

rounded solutions of the owner's problems.

Plenty of work exists for the engineering departments of manufacturing companies in designing the separate units required by plants and systems, improving such equipment and reducing its cost. When such engineers do general or special engineering work they should make a direct charge for it and thus relieve the manufacturing departments of the burden and play fair with all the concern's customers. Engineers have too long been content to allow their compensation to be covered up in the cost of a bill of goods, and this is one reason why the profession is so frequently underpaid and unrecognized. Wherever special designs have to be made, where the installation involves the assembly of numerous elements to furnish which the manufacturer would, in fact, be a jobber, or wherever the installation requires careful examination and analysis of conditions and elaborate study of plans, the best results can be secured by an independent engineer directly in the pay of the owner. On the other hand, where a machine, using the word in a broad sense, is manufactured complete by an engineering organization, and where its duties are so definitely known that they can be made subject to definite guarantees under prescribed conditions, and where the engineering work is primarily an adaptation of standards, the design may safely be made by the manufacturer, though even here the independent engineer can be of great help to the owner.

The independent engineer has the best possible opportunity to design his work so as to confine competition within the limits of the plans and specifications. Where competitive general designs are made by manufacturing companies, conscientious firms frequently lose out to those who skin down the requirements and build only just well enough to secure their pay. Where an installation planned by an engineering manufacturer seems to cost less it is usually because less attention has been paid to operating efficiency, maintenance and future requirements. A dollar spent in the beginning is frequently worth ten dollars afterward. If an owner attempts to obtain the advantages of competition without complete plans and specifications, asking manufacturers to prepare their own plans on the basis of general requirements only, the result is usually bewildering. Few bidders are willing to gamble to the extent of making thorough studies and complete designs and the result is a lot of half-baked plans and prices with liberal allowance for uncertainties. Even in cases where the manufacturer is given a free hand and specifically paid for engineering development work in the absence of full plans prepared by the owner or his engineer there is little certainty that the latter will obtain what he most needs. Complications over responsibility often arise, and in such cases the commercial engineer cannot serve the owner with anything like the efficiency of the consulting or staff expert, who in the long run is the best reliance of the investor in matters of broad technical importance.

Gravity Dam at Humpback Reservoir

Fixed and Movable Wooden Chutes Combined in Placing Concrete
in a Unit of the Sooke Lake Water System at Victoria, B. C.

THE Humpback reservoir is the storage unit in the new Sooke Lake water-supply system for Victoria, B. C. (described in the Engineering Record of Feb. 21), whose location was one of the most important problems of the entire project. The topography of the country between the city of Victoria and the source of the new water system was such that after an exhaustive study it was considered best to place the storage reservoir at a considerable distance from the city, spanning this distance with steel pressure mains. The location finally settled on is $27\frac{1}{2}$ miles from the Sooke Lake intake—over which distance water is brought in a 42-in. reinforced-concrete pipe—and $10\frac{3}{4}$ miles from a small reservoir within the city limits, which is fed from the Humpback reservoir by a 36-in. riveted steel pipe line. The water level in the Humpback reservoir, which has a capacity of 136,000,000 imp. gal., is to be kept at El. 380 above mean sea level, thus supplying all parts of Victoria by gravity and eliminating the present pumping plant which feeds a 135,000-gal. water tower at El. 320.

RESERVOIR SITE AND HEADWORKS

The 380-ft. contour at the Humpback reservoir incloses an area of about 40 acres. Part of this was covered with a shallow peaty deposit, and in order to prevent the water in the reservoir from acquiring taste or color all vegetation and vegetable mold were first grubbed out and removed and then some 5000 cu. yd. of clean sand and gravel were hauled in and spread over the area in a blanket 6 to 8 in. thick. In addition to the main Humpback dam two small auxiliary dams, consisting of a concrete core wall puddled with a clay backfill, were needed to complete the walls of the basin in order to safely retain water up to the 380-ft. level.

The 42-in. gravity-flow line from Sooke Lake enters the Humpback reservoir at the south end of the dam, and three methods of discharge, as shown in the accompanying drawing, were provided. Normally the long flow line will empty into the reservoir over the concrete cascade designed to aerate the water. The direct by-pass into the pressure main is intended for use should the reservoir have to be emptied for repairs, and the submerged discharge pipe is to eliminate the milky condition which is sometimes induced by churning of the water when it contains certain microscopic growths.

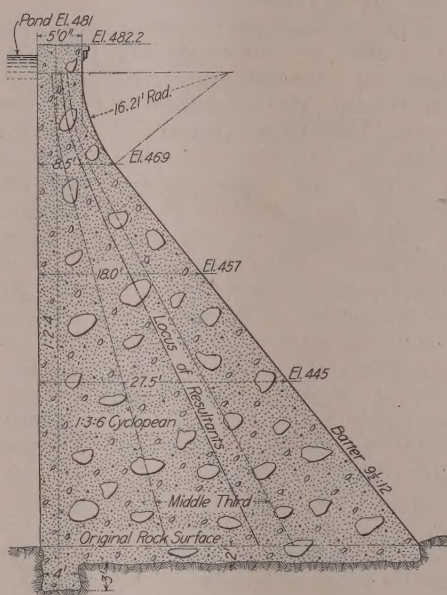
In the gatehouse near the center of the dam are two sluices at the entrance to the 36-in. pressure mains. Only one of these

is used at present, the other being held in reserve until the city outgrows the present provision. Each chamber is provided with two sets of screens, operated by a hand-power hoist. The drainage basin tributary to the reservoir has only little run off, and as the flow from Sooke Lake will be under control the only provision made in the dam for an overflow are sluices, 2 ft. square, in the south end of the dam. Provision for draining and cleaning the reservoir was made by placing a 16-in. cast-iron scour pipe, controlled by a sluice gate, at the lowest surface level near the dam.

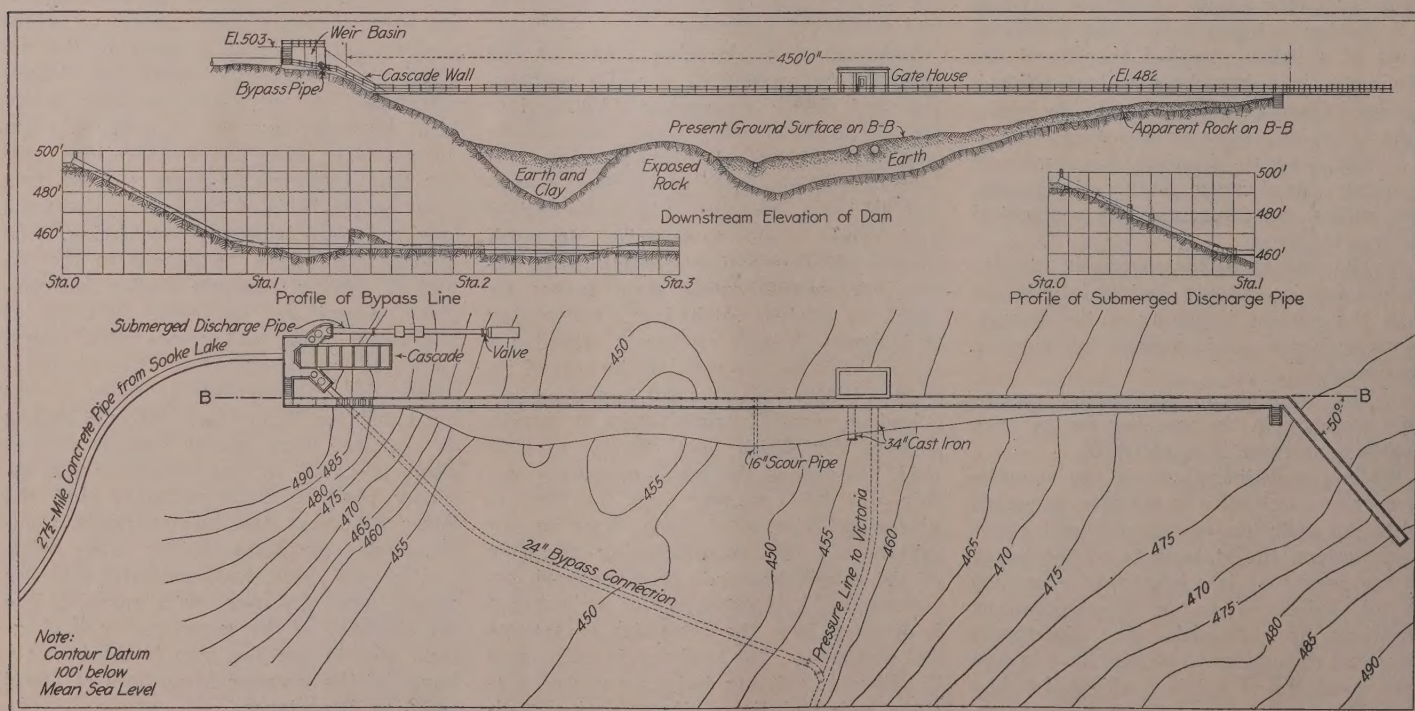
DESIGN OF DAM

The main dam, located at the natural outlet of the reservoir basin, has a maximum height of 60 ft. and a total length, including the north wing wall, of 675 ft. In deciding on its exact location test pits were sunk to rock at various points near the logical position for the dam and that profile which called for the least masonry was selected. The underlying rock stratum is diorite, which shows a well-defined glacial action and is overlaid by a glacial drift. The rock was badly fissured and decayed at the surface, and from 4 to 18 ft. had to be removed in order to bond the concrete firmly into sound rock. There were a number of vertical fissures that required no little attention, as they had to be carefully picked down until they pinched out. One of these, near the north end of the dam profile, was followed to a depth of about 50 ft. below ground surface, the work requiring the protection of a separate cofferdam and a small pump outfit.

The excavating for foundations had been only partly completed when the contractor abandoned the work, and in the delay before the city's forces could commence operations there had been a number of earth slides into



CROSS-SECTION OF DAM



PLAN AND ELEVATION OF HUMPBAC DAM, SHOWING CONNECTION TO SOOKE LAKE PIPE LINE

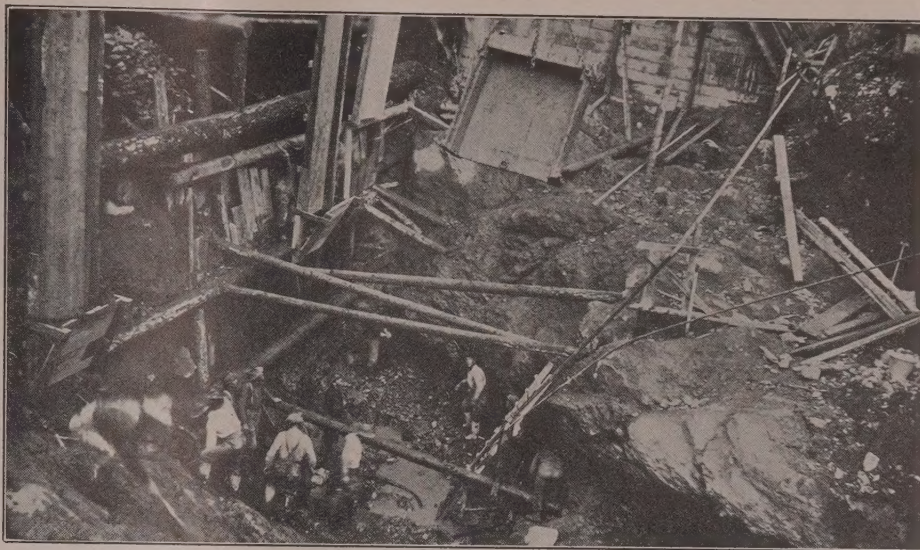
the pit, and the entire excavation had to be pumped out and new protection against flooding provided. The contractor had used cable-operated dump cars for hauling material from the excavation; but this was considered a very uneconomical method, and the engineers for the city installed a stiff-leg derrick with a 75-ft. boom handling 1-yd. skips. This was so placed that it could dump the spoil just below the dam, where drag scrapers were used to level it off whenever it accumulated enough to interfere. Skips were hauled on cars to and from the derricks when the excavation could not be reached by the boom.

CONCRETE MATERIAL.

An attempt was made to locate a suitable gravel deposit near the dam, but the gravel available was not clean; the cost of water and the general expense of installing a washing plant made it preferable to quarry and crush rock. Suitable rock was found about 1000 ft. from the south end of the dam, and a quarry was established here with a No. 5 Austin crusher driven by a 50 hp motor. Two Herzog hammer plug drills and a 3½-in. slugger air drill were provided, all three of which were driven by two of the city's portable gasoline-power compressors. Rock was conveyed in hand cars to the crusher, which discharged into bins over the tracks on which 1½ cu. yd. V-shaped Dolberg dump cars were operated. These cars were drawn by a horse to a trestle near the south end of the dam, under which a storage pile of crushed rock was kept on hand. The relative positions of quarry and track were such that stones were often shot down the hill to the track level, and these were loaded on dump cars and taken to the dam for plums. It was found that on account of the time lost handling plums it did not pay to use a large percentage of them. The number used probably amounted to about one-tenth of the total masonry volume.

Sand was shipped on flat cars from Victoria to a railroad spur about ½ mile from the dam, whence it was hauled up a cable incline in dump cars and then delivered to bins at the dam by a dinky running on a 2-ft.-gauge track. Cement was brought in in like manner and chuted into the storage shed.

Beside the crushed rock storage pile, and just below the cement sheds, a ¾-yd. Smith mixer was set up on an open platform from which it could discharge into 1½-cu. yd. Dolberg dump cars on tracks running out along the upstream face of the dam. These



FINISHING EXCAVATION FOR FOUNDATION OF HUMPBAC DAM

tracks were supported at a level just above the dam crest on a trestle built of pole bents cut in the woods near by and 3 x 12-in. plank stringers. It carried two tracks—one as a main line for engine service in delivering materials and the second, which was nearer the dam, for the cars handling the concrete. Plank chutes were built on the dam side of this trestle, spaced about 8 ft. apart, and below these were hung movable troughs which could be slid along into position under any one of the chutes and fastened at the desired angle by means of ropes. This arrangement is said to have worked out as a cheap and convenient means for delivering concrete at any point on the dam, besides facilitating high efficiency of the plant in service. The usual rate of progress varied from 200 to 250 cu. yd. of concrete placed per nine-hour day, depending on the forms available.

For about 2 ft. back from the upstream face of the dam a 1:2:4 mix was used, while in the remainder of the dam, where plums were put in, the mix was 1:3:6. There were 1210 cu. yd. of 1:2:4 concrete, and adding the cyclopean yardage to this brought the total for the structure up to about 9000 cu. yd. The sides of the foundation excavation were sufficient as forms below-ground surface, and above this 2 x 12-in. plank forms were built with 4 x 6-in. studding and 6 x 8-in. wales. These wales were braced back to the ground in the lower, wider sections, but as the forms

narrowed ⅝-in. tie rods were run through between wales on opposite sides. The dam was sectionalized every 40 ft. with 2-ft. recesses for bonding the sections, and tar paper was used for about 2 ft. along the outside edge of each section to take care of the expansion.

COSTS

The usual full force employed on the work included 6 foremen, 20 mechanics, 2 blacksmiths and 100 laborers. Concreting began about Sept. 15, 1913, and was continued until about the end of the year. The wages were as follows:

	Per hour
Common labor	\$0.34½
Blacksmiths	.45
Carpenters	.53½
Foremen	\$0.50 to .60
Board and camp charges to all were \$1 per day.	

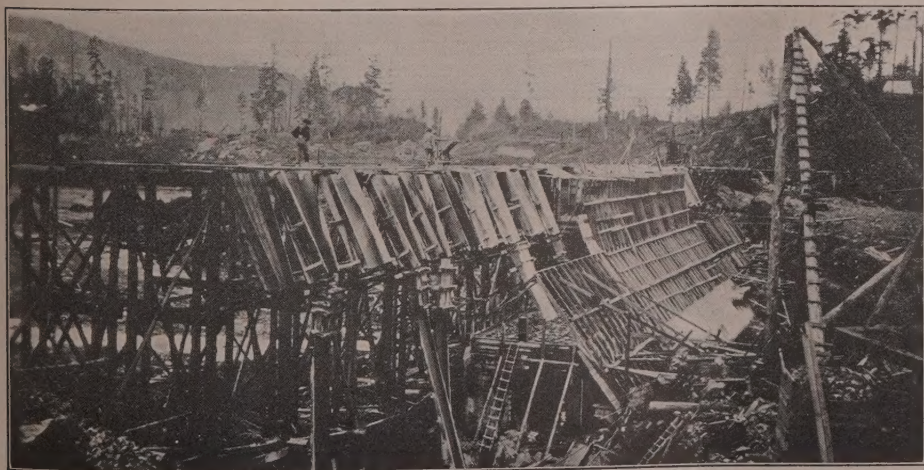
The average cost per yard of all concrete in place was distributed as follows:

Materials	
Cement, 1.01 bbl. at \$2.64	\$2.664
Sand, 0.285 cu. yd. at \$3.13	.892
Gravel, 0.142 cu. yd. at \$1.00	.142
Crushed rock, 0.846 cu. yd. at \$1.72	1.454
Plums, 0.087 cu. yd. at \$1.80	.157
	\$5.309
Mixing and Placing	
Labor	\$0.747
Supplies	.016
Tools and equipment	.014
Mixer plant	.039
Other plant	.021
	\$0.837
Forms	
Total labor	\$0.556
Lumber	.096
Plant and supplies	.021
	\$0.673
Total cost per cubic yard	\$6.821

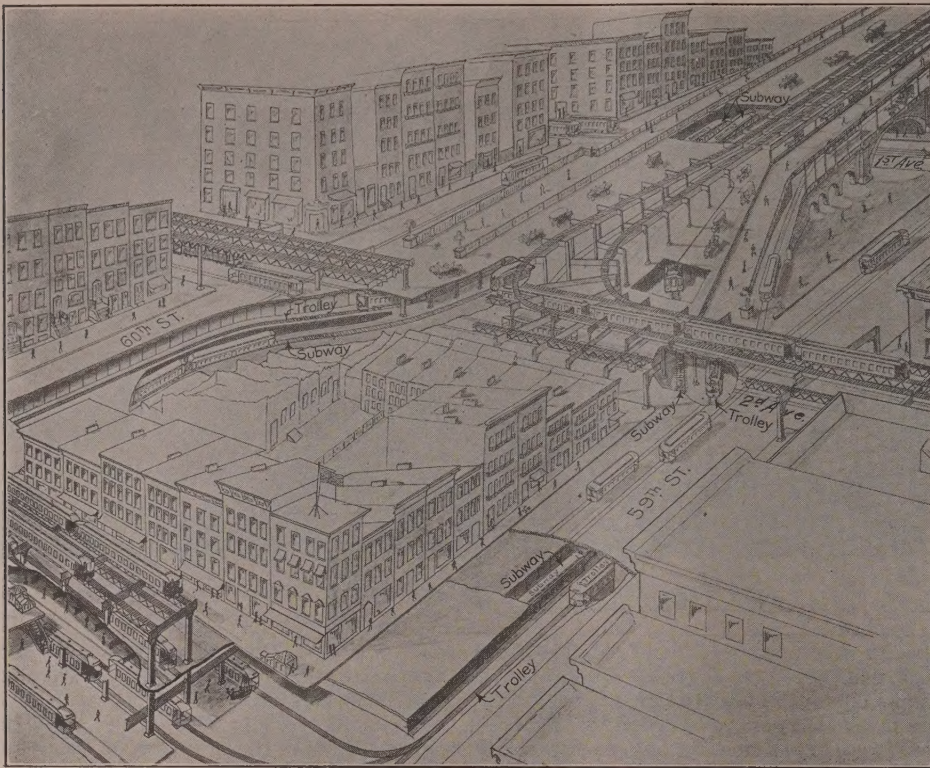
This cost figure, however, includes no charge for rental of plant, which would be cost less salvage divided by 9000.

The work was done by force account after the failure of the contractor. C. H. Rust is city engineer and water commissioner; Wynn Meredith, of Sanderson & Porter, of New York, is consulting engineer, and Boyd Ehle, resident engineer in charge.

THE ZANESVILLE-HEBRON Highway under construction in Ohio, described in the issue of Aug. 1, page 134, has a width of roadway of 16 ft., and not 6 ft., as stated in the article.



FIXED AND MOVABLE CHUTES FOR DEPOSITING CONCRETE



MANHATTAN TERMINAL, SHOWING ELEVATED, SUBWAY AND TROLLEY LINES

Track Arrangement Adopted for Queensboro Bridge, New York City

Terminal Loops, Stations and Tracks Providing for Elevated, Subway and Trolley Lines, with Unimpaired Vehicular Traffic on Both Decks

THE Bridge Department plan, recently approved by the Public Service Commission of New York, First District, for the arrangement of subway, elevated and surface car tracks, pedestrian and vehicular traffic, on the Queensboro Bridge in New York City, differs materially from that contemplated in the original design, from subsequent proposed plans, and from the present tentative arrangement. It consists essentially in the provision of a loop terminal built wholly under the street for the electric surface cars at the Manhattan end, of

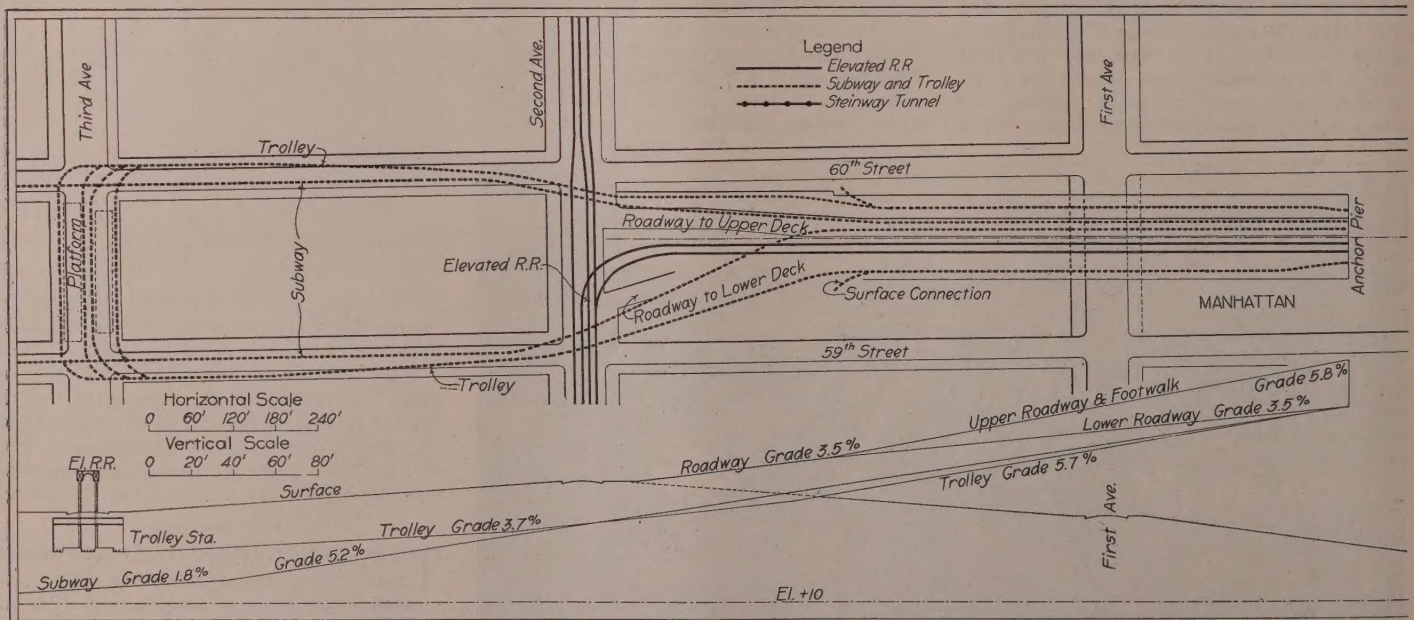
an auxiliary roadway viaduct at the Queensboro end, and of a relocation of tracks providing for two elevated railroad tracks on the upper decks, two subway and two surface-car tracks on the lower deck, a wide driveway on each deck separated from the car tracks, and two new cantilever upper-deck sidewalks. This avoids diminution of driveway space, facilitates vehicular traffic and reduces the previous estimate of cost of installation and terminal facilities. The new arrangement of tracks on both decks, their grades, terminal loops and the

positions of the stations at both ends of the bridge are shown in the accompanying illustrations.

PRESENT AND FORMER CONDITIONS

The bridge was designed and built under the direction of the Department of Bridges, New York City, at an estimated cost of more than \$12,000,000. It was opened to traffic in December, 1903. The five main spans have a total length of 3724.5 ft. on centers of end piers, and are of double-deck construction, 86 ft. wide over all, with trusses 60 ft. apart on centers, all of which was described in many articles published in the Engineering Record while the bridge was under construction. The bridge was not originally intended to carry subway trains, but was designed to provide for four elevated-railroad tracks between the trusses on the upper deck and two surface-car tracks between the truss and two outside of them on the lower deck, with a central driveway on the lower deck and cantilever sidewalks on the upper deck. When it was put into service this plan was slightly modified, as shown in the accompanying sectional elevation, by the omission of the sidewalk brackets, and as no elevated-railroad tracks were then installed, the sidewalks were carried chiefly on the stringers provided for the outside tracks, and no use was made of the stringers for the inside elevated tracks. Surface cars were, however, run on two lines of tracks installed on the lower-deck platforms between the trusses, thus seriously diminishing the nominal efficiency of the driveway 56 ft. wide.

In order to provide connections between the bridge tracks and the present and future lines of elevated and subway railroad in Manhattan and Queens Boroughs several plans were proposed for the rearrangement of subway and surface lines and for an underground terminal station at the Manhattan end, as illustrated in the Engineering Record of Dec. 27, 1913, page 728. The plan then recommended by A. J. O'Keefe, commissioner of the Department of Bridges, provided for two subway and two surface-car tracks on the lower deck and a driveway and two elevated-railroad tracks on the upper deck between trusses, and involved a total estimated cost of \$4,249,000, including an item of \$1,796,000 for the new



MANHATTAN END OF BRIDGE, ELEVATED AND SUBWAY CONNECTIONS AND UNDERGROUND TROLLEY STATION

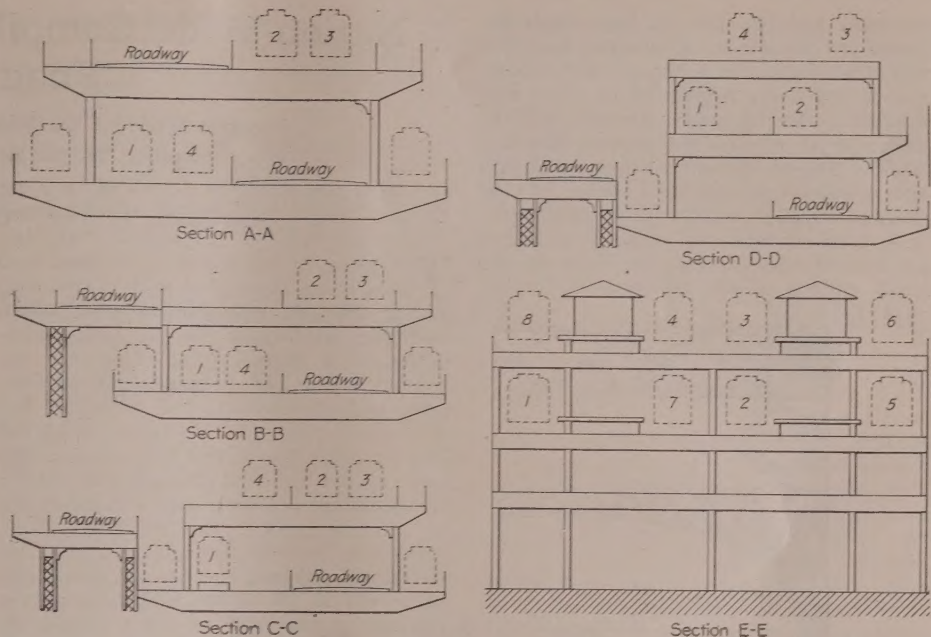
Manhattan terminal and terminal tracks, \$630,000 of which was for the underground station.

Objections to this plan were made, especially in Queens, on account of the restrictions it imposed on the important and increasing vehicular traffic. To meet these objections the arrangement here illustrated has been planned to utilize the existing structure with a minimum amount of structural change, to preserve the full 56-ft. driveway space originally intended and now available, and to benefit it by the elimination of the railroad tracks now laid thereon. The most important changes involved will be the transverse movements of the track alignments in their present horizontal planes and the separation of the driveway platforms into upper and lower-deck levels instead of maintaining them all on the lower deck as at present. The Manhattan underground trolley station will also be shifted so as to occupy a site located entirely between the building lines on Third Avenue, thus affording better traffic facilities and effecting a considerable economy.

ARRANGEMENT OF TRACKS AND DRIVEWAYS

The new plan locates two elevated-railroad tracks on the south side of the upper platform, leaving the north side for vehicular traffic, preferably automobiles and fast-moving vehicles, under police supervision. Cantilever sidewalks are to be constructed for this deck. The two subway tracks will be located on the north side of the lower deck, leaving the south side of the deck, between trusses, for vehicular traffic, and the cantilever portions of the deck as at present for electric surface cars. This arrangement groups the tracks in adjacent lines and balances the truss loads.

The connections to the Second Avenue elevated-railroad tracks will be made at the Manhattan anchor pier. The Manhattan approach to the upper deck will extend from Second Avenue at a 5.8-per cent grade to the anchor pier. The tracks from the subway to the lower deck will be located directly under the approach to the upper driveway and will have a grade of 5.2 per cent. The subway line from Fifty-ninth Street will cross the site of the present underground trolley station, and the latter will be eliminated.



CROSS-SECTIONS OF QUEENS TERMINAL AND APPROACH AT FIVE POINTS

The construction of the new underground-trolley station on Third Avenue between Fifty-ninth and Sixtieth Streets will not involve the purchase of any land and will provide two passenger platforms for the four tracks with loading and unloading facilities superior to those of the present station. Track connections can be provided at the level of Fifty-ninth and Sixtieth Streets between First and Second Avenues to permit trolley cars to run on and off the lower deck of the bridge without passing around the underground-terminal loop.

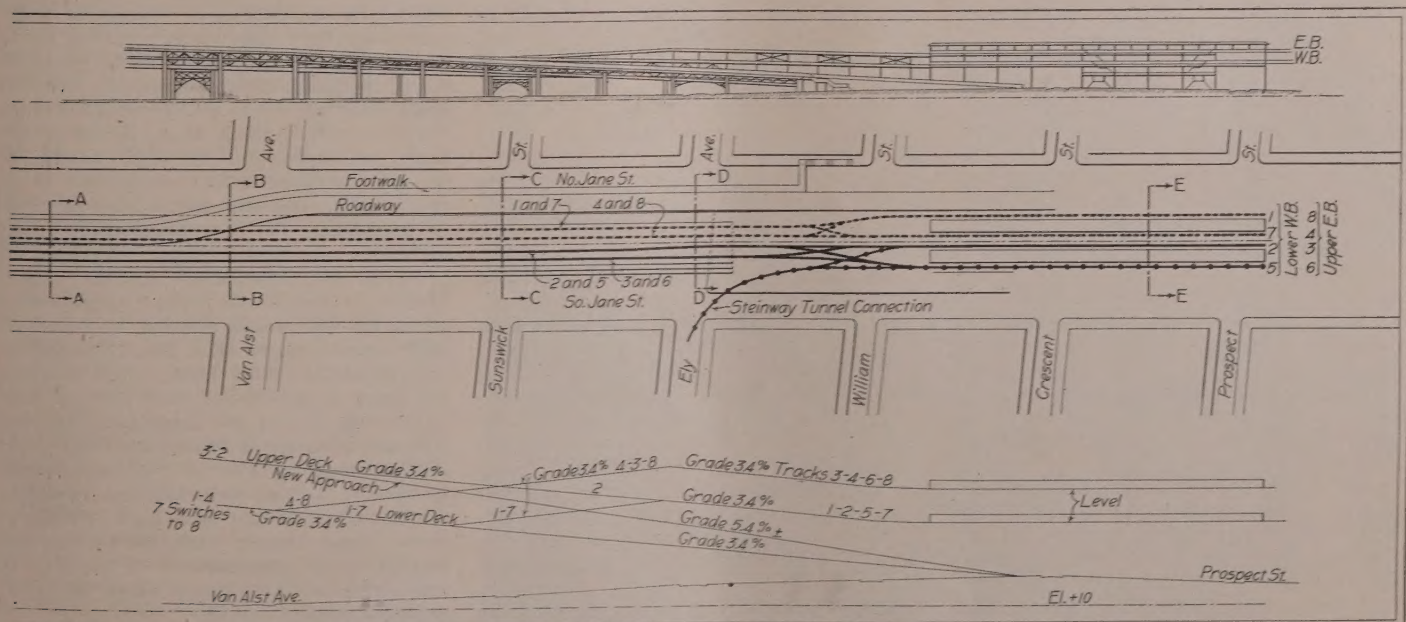
At the Queens end of the bridge, where all of the tracks run into the upper two stories of the Plaza terminal station, the change of grade in the subway tracks interferes with the driveway, and the latter is deflected transversely and carried from Van Alst Avenue to Crescent Street on an adjacent parallel steel viaduct with cantilever sidewalks. This arrangement conforms to the requirements for the new station under construction by the Public Service Commission on the Queens Plaza and is

simpler and less expensive than the plan formerly proposed. The new viaduct has a 5.4-per cent grade, which is not considered excessive for power vehicles, which at present comprise 75 per cent of the roadway traffic on this bridge. Under this arrangement each elevated-railroad and subway track has a capacity of forty-one trains per hour.

COST AND STRUCTURAL CHANGES

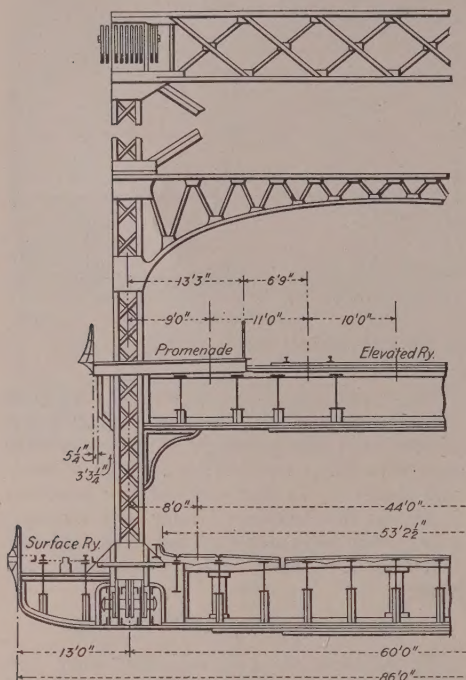
For estimating purposes the work has been divided into four parts, as follows: From Second Avenue to Manhattan anchor pier, \$530,000; from the Manhattan anchor pier to Van Alst Avenue, \$1,308,000; from Van Alst Avenue to Ely Avenue, \$278,000; station at Third Avenue, \$908,000—making a total of \$3,024,000.

Calculations of the stresses produced in the existing structure demonstrate that the maximum properly controlled traffic will not impose loads requiring any strengthening of the trusses. The lower deck must be strengthened to carry two 2000-lb. train loads per linear foot instead of a center



PLAN, PROFILES AND ELEVATION OF PROPOSED DOUBLE-DECK ELEVATED TERMINAL AT QUEENS END OF BRIDGE

driveway and two 1000-lb. train loads between the trusses as at present, and this will necessitate reinforcement of the floor-beams and the construction of some new stringers. In the upper deck it will be necessary to replace the present railroad-track stringers by new roadway stringers and perhaps to reinforce some of the short-panel floor beams. The small sidewalk brackets must be replaced by longer and heavier ones carrying the sidewalks entirely outside of the trusses. It is esti-



HALF-SECTION OF BRIDGE AS BUILT

imated that these improvements can be completed within eighteen months after their construction is commenced.

The design and execution of the work is under the direction of the Department of Bridges, of which F. J. H. Kracke is commissioner, Austin Lord Bowman chief engineer, E. A. Byrne deputy chief engineer, and C. M. Ingersoll traffic engineer.

Performance of Pumps in Duty Test at Springfield

PUMP duty test at Springfield, Ohio, indicated that the new 12,500,000-gal. Allis-Chalmers vertical, triple expansion, crank and flywheel type, single-acting, direct-flow pump exceeded the guaranteed duty of 169,000,000 ft.-lb. of work per 1000 lb. of dry steam by 5,528,125 ft.-lb. George S. Cotter, superintendent of waterworks, in a report to Charles E. Ashburner, city manager, states that during the 8-hr. tests it was necessary to waste the excess, as the capacity was greatly in excess of the consumption.

Pressures were regulated closely by passing some of the water back to the pump well. Duties for each hour varied from 173,550,000 to 176,896,000 ft.-lb. per 1000 lb. of dry steam. A summary of the test showed steam pressures as follows: At throttle, 150.3 lb.; at first receiver, 80 lb.; at second receiver, 1.25 lb.; total net head, 220.1 lb.; piston speed, 222.11 ft. per minute; mechanical efficiency of steam, 95.3 per cent; steam per indicated horse power, 1.12; daily rate, 13,488,573 gal.

Nation-Wide Compilation and Revision of Road Laws

Progress Made by the Joint Committee of the American Bar Association and the American Highway Association

By J. E. PENNYBACKER

Chief, Division of Road Economics, U. S. Office of Public Roads

TO bring about revision of State-road laws along lines that will insure simplicity, efficient management and, where desirable, uniformity, is the task undertaken by a special joint committee appointed at the Third American Road Congress and representing the American Bar Association and the American Highway Association. The magnitude, intricacy and political and technical difficulties of the undertaking seem to make it almost impossible of accomplishment. On the other hand, public sentiment is strongly in favor of revision and reform; the State highway departments in 42 of the States are either actively or passively in favor of the objects for which the committee was formed; the powerful influence of the two great organizations represented on the membership of the committee will count heavily in the accomplishment of results, and, lastly, the co-operation of the Office of Public Roads of the U. S. Department of Agriculture has been secured to aid the committee in obtaining the data upon which to base its constructive efforts.

The personnel of the committee is as follows: Philip T. Colgrove, president of the Michigan State Good Roads Association, chairman; Frederick E. Wadhams, treasurer of the American Bar Association; Austin B. Fletcher, State highway engineer of California and director of the American Highway Association; A. N. Johnson, formerly State highway engineer of Illinois and now highway engineer with the Bureau of Municipal Research, New York City, and the writer, who was formerly secretary of the American Highway Association. Co-operating actively with the committee is Charles Thaddeus Terry, chairman of the committee on uniform legislation of the American Bar Association.

OUTLINE OF WORK

The committee, at its first meeting, held in New York last winter, determined that the first step to be taken should be a literal compilation of the road laws of every State, including not only the laws in active operation but also those on the statute books which have not been repealed and which are, nominally at least, in effect, and that the second step should be a complete analytical index of the legislation to enable the committee to readily detect overlapping laws, ambiguities, obsolete legislation and other vulnerable points for remedial recommendations. It was decided that as soon as the information was available in this form the committee should get in touch with all State bodies or State officials working along similar lines and should endeavor to facilitate such State effort, and that where such State agencies did not exist the committee should recommend through the Governor of each State that the legislature authorize a committee or designate a commission or an official to take up the work with the joint committee.

It was brought to the attention of the joint committee that the U. S. Office of Public Roads possessed the necessary authority

and was properly equipped to make the literal compilation and the analytical index required, and accordingly an official request was made by Mr. Colgrove, chairman of the committee, and by Mr. Terry, chairman of the committee on uniform legislation of the American Bar Association, for the compilation and index. Director Page of the Office of Public Roads promptly granted the request, with the result that there is now nearing completion a literal compilation of the road laws of all the States, carefully cross-indexed and referenced, so that by early fall the joint committee will be in position to take up the next stage of its work, which will be to secure the co-operation of the States.

MATERIAL AVAILABLE

Between three and four million words comprise existing road legislation in the several States, according to the estimate of officials in the Office of Public Roads. This great wilderness of words would make up an edition of thirty fair-sized volumes. In view of the comparative simplicity of the subject, this vast accumulation of statutes is a scathing commentary on the constructive statesmanship of our legislators for many generations. There is scarcely a doubt that at least 85 per cent of the legislation is superfluous and that, entirely aside from the matter of reform, exactly the same purposes contemplated in the existing legislation could be accomplished with greater effectiveness with one-eighth of the existing statute laws.

To indicate the comparative industry with which legislatures have accumulated good-roads statutes, it is shown from the compilation that New Hampshire has an excess of road legislation as compared with Vermont to the extent of 10,000 words. Inasmuch as these two States are quite similar geographically, topographically, and in political organization, it is difficult to determine why there should be a necessity for so much difference, and it is yet to be determined whether New Hampshire has too much road legislation or Vermont too little. Vermont in turn leads Rhode Island in verbosity of legislation by 3000 words, although the latter State is supposed to be most highly organized and to have all needful legislation for the management of its highways. Towering above all three of these States in wealth of statutory enactment is Pennsylvania, with an aggregate of about 125,000 words relating to roads, or 80,000 words more than New Hampshire.

Even at this, New Jersey must be given the palm as the "busy little bee" in road legislation, for in the aggregate its road laws exceed those of Pennsylvania by about 50,000 words, for a total of 175,000 words. In view of such an overwhelming burden of road enactments the local road officials of New Jersey should each be allowed six months after appointment or election to read over the laws under which he is expected to render service.

Surely, with conditions that do not differ radically there should be no occasion for

such wide disparities. In view of these conditions a State which compresses its road laws into 10,000 words should become noted for laconic simplicity, while any record below that figure should be engraved on tablets of bronze and carefully preserved in the National Museum at Washington.

COLONIAL LAWS STILL IN EFFECT

The compilers have found legislation still in effect almost identical as to form and substance with the old Colonial road laws, which were in turn based upon English precedent, extending back to the time of Queen Elizabeth; they have found statutes so hopelessly in conflict as to make efficient and responsible administration utterly impossible. As an example of the bewildering confusion of existing legislation, the compilers came across, in the statutes of one of our most progressive States, a recent enactment amending a road law which was repealed two years before the amendment was passed, and yet apparently none of the legislators have thus far become acquainted with the situation.

They have found many and various other sins of commission, but the sins of omission are equally great. They find a very general lack of statutes requiring qualifications for the holding of positions to direct the construction and maintenance of roads and bridges; they find a general lack of legislation defining authority and responsibility for properly safeguarding road revenues, these negative faults relating to personnel and revenues being the most serious of all the charges which the committee will ultimately bring.

FUTURE LINES OF ACTIVITY

It is evident from the foregoing that the committee has on its program several lines of activity. The first is to bring order out of chaos through repeal, amendment and revision, whereby road legislation in each State will be simple and compact. The second line of activity will be to urge the elimination of statutes which do not adequately meet the requirements of modern conditions and to substitute for them measures framed according to the very best existing theory and practice. The third distinct line along which the committee will move will involve the preparation and submission of purely constructive legislation to cover those needs of the States which have never been reached by legislation, and finally to endeavor to harmonize and correlate the road laws of the various States so as to bring uniformity, partially or wholly, wherever such uniformity seems desirable.

The committee will report its progress at the fourth American Road Congress, which will be held in Atlanta during the week of Nov. 9. The practical and useful results to be anticipated will depend largely upon the measure of co-operation which the committee may receive from the various States.

State effort has not been entirely lacking in the endeavor to accomplish revision and reform similar to that undertaken by the joint committee. State commissions have been appointed during the past 20 years to compile road laws, investigate conditions and recommend new legislation. The present State road laws in New York, Massachusetts and Illinois are, to a considerable extent, the outcome of recommendations by State commissions, while Ohio and Indiana now have official commissions engaged upon similar work. Several other States have compiled their road laws but have taken no

further steps looking to revision. Iowa now has perhaps the most comprehensive road law in the Union, as it gives the State highway department general control over all road work in the State.

At the session on State legislation to be held at the fourth American Road Congress the joint committee will urge that steps be taken looking to the establishment of an interstate official body, composed of repre-

sentatives of each of the States, so that the work of revision may be properly correlated and each State saved the necessity of laboriously going over the same ground. No better work could be done for the furtherance of good roads throughout the United States than to bring about the substitution of simple, efficient road laws for the chaotic mass of enactments now to be found on our statute books.

Steel Framework of Adams Express Building

General Features of the Very Heavy Foundation Girder System and of the Wall-Girder Wind Bracing of New York Skyscraper

THE 32-story Adams Express Building at 61 Broadway, New York City, occupies a 107 x 202-ft. area. The 13,250-ton steel framework of the superstructure has 54 main columns with plate-girder and grillage foundations on twenty-four pneumatic-caisson concrete piers sunk through quicksand to rock at a maximum depth of 70 ft. below the curb, as described in the Engineering Record of Sept. 21, 1912. Two of the piers carry single columns, most of the remaining ones carry two columns each, and some of them three, which, often being unsymmetrically arranged, necessitate very heavy cantilever and distributing girders to transmit their loads properly to the grillage beams covering most of the pier tops.

Data as to the methods of designing the steelwork will be found in an accompanying article by H. R. Burroughs.

FOUNDATION GIRDERS

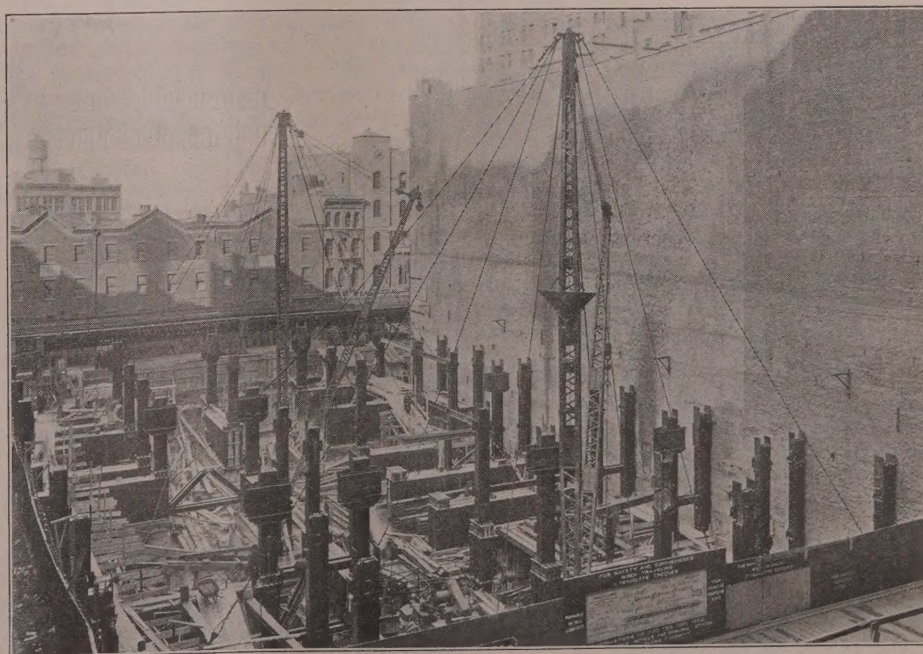
All of the piers are rectangular in form, most of them being relatively long and narrow, with average dimensions of $7\frac{1}{2}$ x 28 ft. At each corner of the lot two of these piers, with their long sides parallel and about 22 or 23 ft. apart on centers, have their upper surfaces covered by the bottom flanges of 24-in. grillage beams bolted together with separators, in sets of four or five, and extending continuously across the space between the two piers, but without allowance being made for support on the soil between them.

At or just beyond the corners of the

parallelograms formed by these grillage beams four columns are located and balance one another through the double web-plate girders which support them. The girders are seated across the extremities of the grillage beams, with their ends slightly overhanging, thus forming cantilevers. The column bases are seated on I-beams built up of pairs of 15-in. heavy channels riveted together back to back with reinforcement plates between their webs to resist the heavy shear from the maximum column loads of 1800 tons.

The intermediate wall columns are seated on sets of plate girders, which act mainly as distributing girders, but overhang the masonry to a slight degree, thus developing some cantilever action. The broad bottom flanges of the girders cover so large a proportion of the surfaces of some of the pier tops that additional distribution through grillage beams is not necessary, and the latter are omitted.

In cases where a third column is seated on the girders near the wall columns it is connected with the interior column by one, two or three additional girders, giving an increased section for the maximum moment. The girders which support the interior columns singly or in pairs are double and are seated on transverse grillage beams distributing their loads over the pier tops. The depths of the girders vary from 69 to 117 in., their web plates are from $\frac{1}{2}$ to $\frac{11}{16}$ in. thick, reinforced by plates from $\frac{5}{16}$ to $\frac{7}{16}$ in. thick, and the flanges are

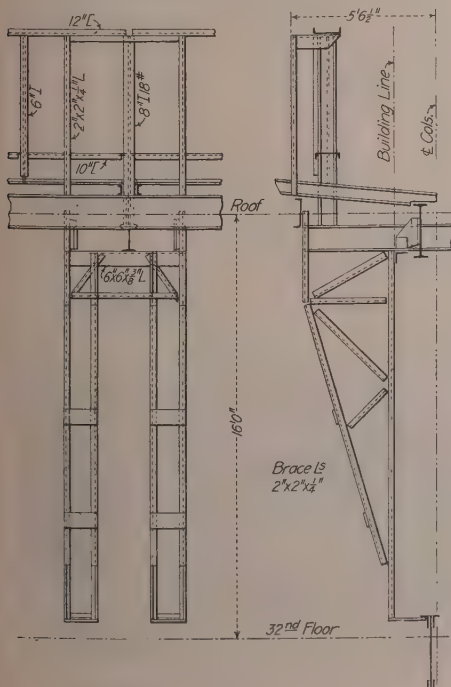


PROGRESS VIEW OF ERECTION OF ADAMS EXPRESS BUILDING



STEELWORK IN ADAMS EXPRESS BUILDING

5 ft. apart, with short stiffener angles intermediate between them on the lower portions of the webs. The web plates are spliced with double cover plates proportioned to take bending moments as well as shear. The ends of the stiffener angles are milled to bear against the flange angles and the center web plate is made of full width and chipped to bear on the flange cover plates. All rivets are 1 in. in diameter. The girders of each pair are independent of one another, except that under the column bearings the web stiffeners are connected by short vertical angles shop-riveted together



CORNICER AND ROOF BALUSTRADE

back to back and field-riveted to the girders. The other foundation girders correspond with those here illustrated.

The column plan changes at the twentieth floor, above which to the roof six of the columns are carried intermediate between the columns in the lower stories by pairs of plate girders 4 ft. deep with their web plates field-riveted across the bases of the lower-story columns. The girders are of ordinary construction, with a maximum length of about 30 ft. and weight of $7\frac{1}{2}$ tons, and have single $48 \times \frac{3}{4}$ -in. web plates, and pairs of $8 \times 6 \times \frac{7}{8}$ -in. flange angles with a 14-in. cover plate.

WALL GIRDERS

The framework is stiffened and resistance to wind stresses is afforded by the depth of the wall girders and of their connections, which virtually provide sway bracing in the panels between columns. On the long side of the building, opposite Exchange Alley, where nearly all of the wall is located on the lot line adjacent to the next building, most of the wall girders are pairs of 18 and 24-in. I-beams. In the other exterior walls the riveted girders are from 30 to 40 in. deep, with field-riveted connections to the columns, which vary according to the relative position of the girder and column webs, and are of standard uniform size. Where the girder webs are parallel to the column webs special short sections of the latter are made wide enough to project beyond the flanges, through slots in the flange cover plates, to receive the connections to the girders. Where the column webs are at right angles to the girder webs short sections of the flange cover plates are made wider to receive the girder webs and are deeper than the girders to serve as gusset plates. From the first to the thirty-second story there are two lines of transverse double interior portal girders from 36 to 46 in. deep with their webs parallel to the column webs. The webs of these girders are cut short enough to clear connection plates on both sides of the columns, which are field-riveted to vertical connection angles, which are shop-riveted to the column flanges. These plates are deeper than the girders and project below their lower flanges, where they are stiffened by inclined flange angles and horizontal angles forming gusset plates and seats for the bottom flanges of the girders. The girder flange angles engage the column connection plates and are spliced across the columns by short lengths of angles.

All spandrel and portal girders are treated as continuous over intermediate supports. The section moduli of the gusset plates connecting spandrel girders to columns, from the basement to the twenty-eighth floor inclusive, are 10 per cent greater than those of the connecting girders, and above the twenty-eighth floor are equal to those of the connecting girders. The combined section moduli of the gusset plates and side angles connecting portal girders to columns from the basement to the twenty-eighth floor inclusive are 15 per cent greater than that of the connecting girders, and above the twenty-eighth floor are equal to those of the connecting girders.

Francis H. Kimball is the architect of the building and Weiskopf & Burroughs are the consulting engineers for the foundations and structural steelwork, which was detailed, furnished and erected by Post & McCord. It was fabricated by the American Bridge Company.

Design of Adams Express Building

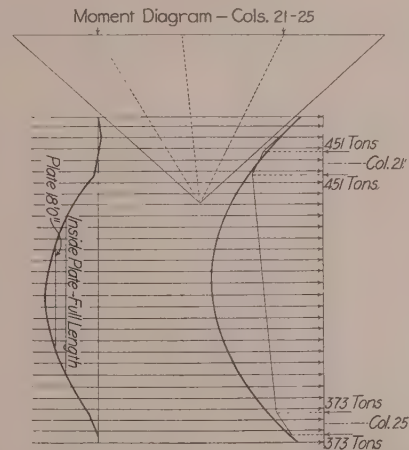
Methods of Proportioning the Steel Frame, Including Foundation and Wind-Bracing Girders

By H. R. BURROUGHS

Of Weiskopf & Burroughs, Consulting Engineers, New York

THE Adams Express Building, on Broadway opposite Exchange Place, New York City, is a tall office building of 32 stories above the ground surface, with basement and sub-basement extending about 30 ft. below. The height of the building from curb to base of the 75-ft. flagpole is 437 ft. and from sub-basement to top of flagpole 540 ft. The building covers an area of 107×202 ft. at the first floor. Above the second floor there is a court on the south side with dimensions of 41×61 ft.

The foundations for the building are of the concrete pier type and were sunk in pneumatic caissons to bedrock, which underlies the site at an average depth of about 65 ft. below the curb. The piers are of such



MOMENT DIAGRAM FOR FOUNDATION GIRDERS

dimensions as will sustain the imposed load with a pressure on the concrete of 18 tons per square foot, which, with the weight of the piers, gives a pressure of 18 tons on the rock.

Exterior rectangular piers along the north and south building lines were arranged to act as buttresses and as a means of retaining the imposed earth pressure and also the surcharge due to adjacent buildings. This arrangement reduced to a minimum any danger which might arise from settlement of adjoining property.

Preliminary test core borings were made at the site for the purpose of determining the nature of the ground formation and elevation of bedrock. These borings were carried 10 ft. into bedrock in order to be sure that bedrock had been reached.

FOUNDATION GIRDERS AND FLOORS

In designing foundation girders the usual method of statics was employed, one-eighth of the web being assumed as flange area and the usual moment diagrams being drawn, as typically shown by the diagram herewith.

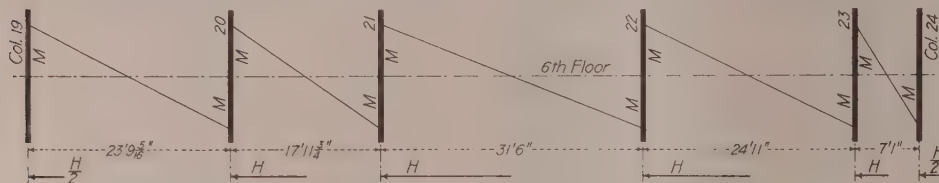
Floor loads of 150 lb. live and 100 lb. dead were used for the first floor and basement. For all floors above the first, loads of 75 lb. live and 95 lb. dead were employed.

Floorbeams and columns were designed to sustain these loads. Wind columns and girders were designed to resist also a wind pressure of 30 lb. per square foot on the

exposed surface of the building, from the top down to the fifth floor, with a working stress increased 50 per cent over that used for the dead loads. For convenience in the computations a stress of 20 lb. per square foot was employed. Columns were designed with the permissible dead and live load unit stresses of the New York building law.

The wind was considered to be resisted transversely by two intermediate portal towers and by two exterior spandrel towers, each of which carries its respective portion of the exposed area. The building is braced longitudinally by spandrel girders on the south side and by a solid brick skeleton wall on the north. The wind bracing consists of single and double plate girders riveted to the sides or webs of columns at the wind-tower bents. This type was employed throughout.

As illustrated in a diagram accompanying this article, the total wind load at each floor is resisted by five girders, which were treated as continuous over intermediate supports and fixed at exterior columns, with their points of contraflexure at midspan.



TYPICAL WIND-BRACING BENT AT SIXTH FLOOR OF ADAMS EXPRESS BUILDING

Outside columns are consequently subject to one-half the amount of shear taken by inside columns, and, likewise, the bending moment is only one-half.

This method of figuring is as follows: The accompanying diagram represents a typical wind-bracing bent at the sixth floor. The total shear at this floor is 207.2 tons. The bending arm as applied to these columns is 50 in., giving a total bending moment of 10,360 tons. As exterior columns take half as much wind moment as interior columns, the total bending moment, 10,360, divided by 5 equals 2072 inch-tons for the bending moment on interior columns; 2072 divided by 2 gives the bending moment on exterior columns. Columns were treated as continuous with their points of contraflexure midway between supports.

As these girders have their points of contraflexure at the middles of their respective spans, we have an equal resistance at each girder connection, and therefore, having five girders, there are ten connections to resist the total bending moment. The total girder bending moment in foot-tons for this floor is 2590; dividing by 10 gives a bending moment of 259 foot-tons for each span due to wind. To this moment should be added the bending moment due to dead and live load, considering the girder as a continuous beam of five variable spans. The sum of these two would be the determining moment for girder sections.

It was considered that any one girder of a series would not deform from wind stresses without the other girders of the same series taking action. Therefore, the bending moment due to the wind at any particular floor was considered as constant for all girders of that portal regardless of the length of span. It was found unnecessary to splice any columns for either bending or direct tension, as in each case the direct compressive stress on the columns exceeded the maximum tensile stress.

Dismiss Charges of Discrimination in Water Rates

Right of Private Company to Resist Competition of City by Non-Uniform Rebating Defined by Pennsylvania Court

A COMPLAINT brought against the Bethlehem City Water Company, a private corporation, charging discrimination in allowing an extra rebate for prompt payment to consumers on streets on which a municipal company had introduced a competitive service, has been decided in favor of the defendant by the Public Service Commission of Pennsylvania. Commissioner Samuel W. Pennypacker stated in his decision that the extra rebate did not constitute a discrimination, especially insofar as serious competition had been introduced, to meet which it was necessary to lower the rates or lose the business, thus rendering valueless that part of the investment.

West Bethlehem has been supplied by the private company almost since its in-

corporation. The company has never declared a dividend on the stock, and its net earnings, now about \$30,000 a year, have been expended in paying interest on the bonds and extending the plant. It filters a supply obtained from the Lehigh River and springs. In 1913 the Borough of Bethlehem extended its water mains, which are supplied with artesian water much harder than the other, to several streets in West Bethlehem, proposing to furnish water at rates lower than those of the private company. The latter, which already allowed a 25-per cent rebate for payment of bills within thirty days, thereupon made an additional discount of 15 per cent to consumers on the streets invaded, numbering 100 out of the 957 total consumers claimed by the private company. Complaint was then made by individuals, who stated that the granting of the 40-per cent rebate was a discrimination under a paragraph of an act passed in 1913.

NO PROFITS FOR THIRTY YEARS

The decision recalls that the private company has invested large sums and has for thirty years supplied the people with a necessity of life without any return made to its stockholders. It now finds the territory it had occupied invaded and its rates, presumed to be reasonable in the absence of evidence to the contrary, assailed. Commissioner Pennypacker goes on to state that the greater or lesser compensation forbidden by the act of 1913 is that of a charge "for a like and contemporaneous service under substantially similar circumstances and conditions." While it is manifestly the purpose of the act that public-service companies should be supervised and controlled, he proceeds, and that everything in their conduct unreasonable or unfair should be prevented, there is nothing to indicate any intention to destroy vested interests or to hamper the proper exercise

of the powers conferred upon such companies. After citing two cases of railroad rate-making having parallel features, the decision concludes as follows:

"In the present case with respect to the streets to whose residents the greater discount was allowed by the respondent, there was competition of a serious character. To these residents another supply was offered at lower rates. The undisputed testimony is that it was necessary 'to meet their rates or lose the business entirely.' To lose the business would be to render valueless the investment in that part of the plant. The competition was the more threatening because of the fact that it had the strength and power of the municipality to support it. As to what constitutes such competition as will create a dissimilarity of circumstances and conditions must be determined from the facts of each case as it arises. After giving careful consideration to the ascertained facts and the situation as it exists in West Bethlehem, it is our conclusion that such dissimilarity between the conditions upon the streets named and the others exists as to make the prohibition of the statute inapplicable."

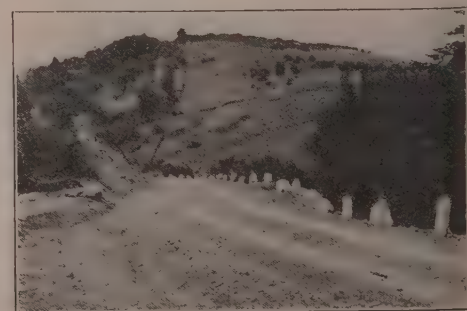
Guard Rails on Mountain Roads

Use of Large Rocks Painted White on Highways Where the Expense of Building a Solid Fence Is Not Warranted

THE use of guard rails on highways, the California Highway Commission finds, may serve a threefold purpose—namely, as a protection, as a warning and as an attractive finishing touch to the completed work.

A solid guard rail intended for protection should not be built during the construction period, it was recently decided at a seminar of department heads of the commission, but should be added after the embankments have settled. Since there is a sacrifice of roadbed width in connection with this point, it was recommended that the standard wooden guard rail should be replaced with substantial iron or concrete construction wherever renewals became necessary and the requisite funds were available.

On mountain roads much used by teams the guard rail is important chiefly as a warning, because these vehicles usually carry no lights. Hence a white border along the danger line adds materially to the ease and safety of driving on dark nights, and the accompanying photograph illustrates an effective and inexpensive method of providing such warning. The rocks are placed from 10 to 20 ft. apart and painted white.



WHITENED STONES TO MARK EDGE OF ROAD



DRILL CARRIAGE WITH FOUR DRILLS WORKING AT THE TUNNEL HEADING

Construction Plant for Mount Royal Tunnel

Special Drill Carriages, Small Storage-Battery Locomotives Originally Designed for Gasoline Operation, and Other Novel Equipment

By W. C. LANCASTER

Electrical and Mechanical Engineer, Mackenzie, Mann & Company, Limited, Montreal

ALTHOUGH much has been published about the engineering features of the 3-mile Mount Royal tunnel of the Canadian Northern Railway at Montreal (see the Engineering Record of June 28, 1913, page 708) practically nothing has been said about the construction plant, which is entirely electrical. Work on the tunnel was started from three points—the west portal, the Maplewood shaft, which is just a mile from the west portal, and the Dorchester Street shaft. As most of the work was to be carried on west of the mountain and as an abundance of space was available at the west portal, that point was selected as the location for the larger part of the plant as well as for the main storehouse, the store yard and the camps. Aside from the plant as a whole, of special interest are the special drill carriages, and the cars and locomotives for handling the spoil.

Drilling in the tunnel has been done with rock drills driven by compressed air, the equipment consisting of fifty-two 2 $\frac{5}{8}$ -in. Sullivan water drills, twelve 3 $\frac{1}{4}$ -in. and twenty-one 3 $\frac{5}{8}$ -in. Sullivan drills and fifteen Hardy hand-hammer drills. The water drills were essentially ordinary reciprocating drills with the piston and rifle bar bored out to permit the insertion of a small water tube, adjustably secured in the back head of the machine. Excellent results were obtained with these drills.

For the heading work four drills were mounted on a horizontal bar, all being carried on the arm of a drill carriage. There were two of these drill carriages. One of them is shown and consists of a beam of H-shaped cross-section, carried on a roller and so arranged that through gearing it can be moved in and out over the roller by a small electric motor. Movement of

the beam in a vertical plane is made with two screw jacks geared to a motor, and in a horizontal plane by a worm and gear also driven by an electric motor. Through the steel frame carrying the beam a 16-in. belt conveyor is run. The muck is shoveled upon this belt and is carried by it back from the face and loaded into cars. The conveyor is driven by a small Dake engine operated by compressed air. The whole is mounted on small but massive trucks on which the combination carriage and conveyor is pushed up to the face by an electric locomotive. When as near the face as the muck pile will permit, the beam carrying the drill bar and drills is extended until the drills are at the face. During this operation the beam is moved up and down or sidewise to the correct position, in which it is braced by jack screws against the sides of the heading. These various motions of the beam are all controlled by one man and accomplished simply by starting the corresponding motors with ordinary knife switches.

The other drill carriage accomplishes the same result as the one just described, but is somewhat slower, as the horizontal and vertical movements of the beam are made by hand by means of screw jacks against the sides and top of the tunnel. It also differs from the other in having no belt conveyor, the beam being jacked up to the roof and held there and the remainder of the carriage being moved back out of the way of the muck cars. Both carriages were built on the work.

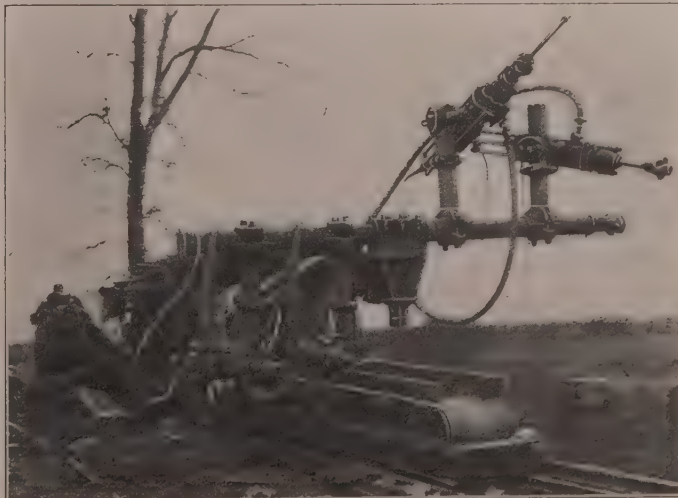
DRILL SHARPENERS

Owing to the hardness of the rock a great many bits were required, too many to be economically sharpened by hand. Three Word drill sharpeners were, therefore, installed. It has been found that as many as an average of 600 bits per eight-hour shift can be sharpened with one of these machines.

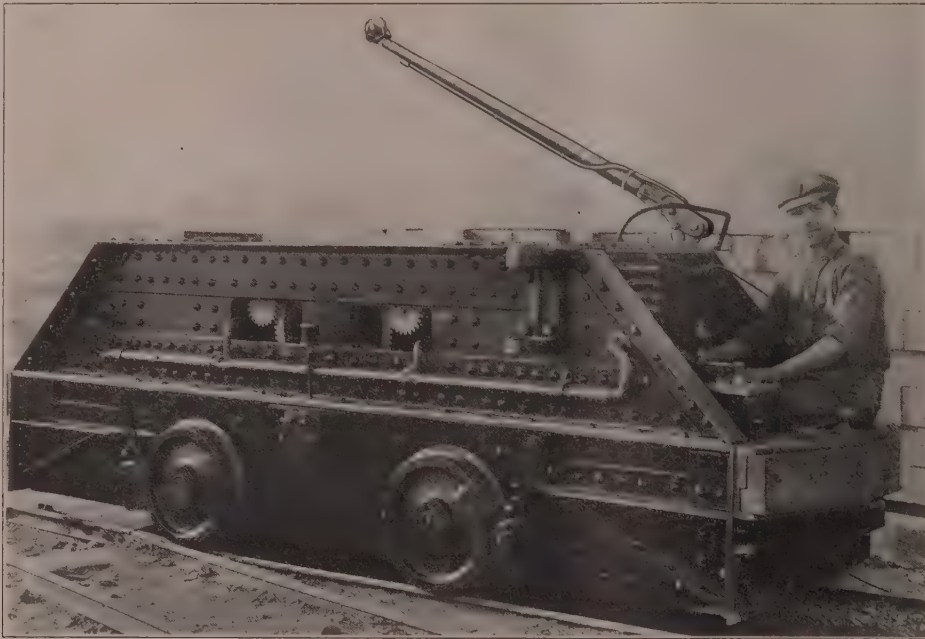
With the exception of steam for heating and for operating a 30-ton dinky and a locomotive crane, all power used is electric. This is purchased at the main plant at 11,000 volts and stepped down to 2200 volts. Most of the power is used at this voltage for the motor-driven air compressors, the remainder being again stepped down by other transformers in the same building to 550 volts for all the small motors and 110 volts for lighting. At the Dorchester Street end of the tunnel there is a similar installation, except that the power



TUNNEL LOCOMOTIVE AS OPERATED AT FIRST BY GASOLINE



DRILL CARRIAGE WITH BELT CONVEYOR FOR REMOVING SPOIL



ONE OF TWO 7-TON TROLLEY LOCOMOTIVES BUILT IN THE JOB MACHINE SHOP

is delivered at 2200 volts, so that no large transformers are necessary.

There were about 175 tunnel cars for hauling out the muck, all built in the machine and carpenter shops on the job. They were built especially strong to withstand the strain due to the rock falling into them from above, a condition imposed by the bottom-heading method of tunnel driving that was used. The inside of the car is lined with steel plate only on the bottom and the end door, where most of the wear occurs.

There were six small storage-battery locomotives to haul these cars. The storage battery was carried on a trail car, there being two batteries for each locomotive. These locomotives were originally operated by gasoline. It was hoped that the carbon monoxide in the exhaust could be changed to dioxide by passing over lime, but this was only partly successful. The fumes finally became so objectionable that 110-volt electric motors were substituted for the engines, the locomotive gearing being left practically without change, and the trail car with a sixty-cell storage battery being added to supply the current.

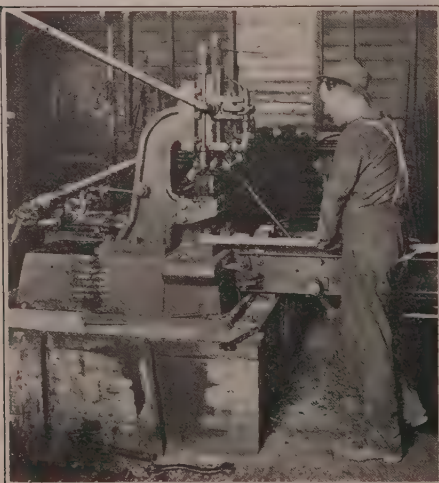
Recently, since the hauls have become longer and a larger tunnel cross-section has been available so that a trolley wire could

be used, these same locomotives have undergone still another change. A trolley pole and another 110-volt motor have been added, the two motors operating in series and being supplied with 220-volt power from the trolley wire.

In addition to these six gasoline-storage-battery-trolley locomotives there are one 6-ton and two 10-ton 250-volt General Electric trolley locomotives, and two 7-ton trolley locomotives built in the job machine shop. One of the latter is shown.

At the Maplewood shaft, which is 240 ft. deep, and at the Dorchester shaft, electrically operated self-dumping cages were installed. These were manufactured by the Eagle Iron Works.

All rock taken out of the west portal is crushed in a plant consisting of two No. 7½ Kennedy gyratory crushers, a 75-ft. elevator for taking the crushed rock up to a 48-in. x 24-ft. screen, four belt conveyors for storing the different sizes of stone, and a No. 4 crusher for crushing the rejections. Bins are provided from which cars underneath can be easily loaded, the stone going out on the conveyors to the piles only when these bins are full. The loaded cars from the tunnel are pulled up an inclined track to a tippie by means of which the rock is dumped into the crushers. An electric hoist pulls the cars up the incline, the pulling rope being fastened to a dummy car of a narrower gage than the tunnel cars. A similar dummy is used on the other track of the incline to lower the empties after their loads have been dumped by the tippie into the crusher.



MACHINE FOR SHARPENING DRILLS

THE NEW STEEL CONDUIT now being completed for augmenting the water supply of Atlantic City is being used as an effective advertising medium. For about a mile the pipe parallels the line of the Pennsylvania Railroad, and, being entirely above ground, makes an excellent signboard. The Chamber of Commerce has painted large signs on it at intervals of about 300 ft., extolling the advantages of the city as a summer resort. The scheme is effective, for travelers follow the successive signs with much interest.

Paris Inundation Plans

Commission Recommends Enlargement of Arm of Seine at City Island and Deepening of Channel at Suresnes

By FRANCIS P. MANN
Paris, France

AFTER the 1910 inundations of the Seine at Paris a special commission was appointed by the State to take defensive measures, and three months later it presented a report on the subject. At the same time a municipal commission of like character held its sessions. As a result the city of Paris recently voted \$7,000,000 for its share in the work, and Parliament is to vote an equal sum. M. Dausset, of the Municipal Council, gives the following points about the scheme in the daily press: Until lately, accord between the three interested bodies—the State, the municipality and the Seine Department—was difficult owing to divergencies of views and the great scope of the work. The State commission recommended enlargement of the small arm of the Seine at City Island, the rebuilding of four bridges and demolition of the barrage on the Seine arm and deepening of the Seine bed in the suburbs near Suresnes.

The project of an offtake canal from the Marne, a confluent of the Seine above Paris, served as the basis for discussion and gave rise to numerous reports and considerable difference of opinion. A discussion arose as to the desirability of such extensive work as enlarging the Seine arm and deepening the bed at Suresnes without being sure that this will prevent inundation. The municipality considered that if only the two operations just mentioned were carried out it would not be possible to reduce the flood level to which the river rose during the 1910 inundation—at least to any great extent. On the contrary, in accordance with eminent authorities, it concluded in favor of a vast operation of a comprehensive character, including the deepening of the Seine bed from Port à l'Anglais, well above Paris, down to Poses, near Rouen. Such deepening of the stream to 4.50 m. (15 ft.) will have the effect of lowering the level by at least 1 m., and the freshet level will be reduced accordingly. Navigation is bettered considerably by allowing barges of heavier draft to come from Rouen to Paris, so that the great expense will be partly covered.

GENERAL DEEPENING OF SEINE

After the exposition of the plans an agreement was finally reached between the city and the minister of Public Works last December, and the latter became convinced of the need of carrying out this vast and comprehensive scheme, of which the enlargement of the Seine arm and the deepening at Suresnes are only the start, and it was understood that the general deepening of the Seine would be planned and executed. It is also for this reason that the Municipal Council and the Seine Department Council approved the report presented by M. Lemarchand and M. Robaglia and voted affirmatively, in December on the two operations just mentioned. The municipality formally engaged to furnish the sum of 35,395,000 francs (\$7,000,000), one-half of the amount needed, the other half to be supplied by the State. It is upon this project that Parliament will be called upon to vote in the near future.

The diversion canal for the Marne River is under consideration and Parliament is to decide under what conditions and at what time such an operation is to be commenced and realized. It will thus be seen that the municipality is taking all possible measures, and will negotiate a departmental loan scheme to cover the expense needed to protect Paris and the departments against the inundations. Since the city has now pledged itself, the nature of the financial operations is only a matter of detail. It is to be noticed that even if this program had been voted a year or two ago the actual work would hardly have been started at present, so that the scheme could have had no effect on the question of the 1913 freshets, and these would not, therefore, have been lowered.

RAISING EMBANKMENTS

The municipality did not stop with the plans above mentioned, and as concerns the work which falls exclusively on the city, it decided to carry out an extensive program for raising the level of the Seine embankments. It has already decided to raise certain embankments above the 1910 freshet level, which will cost 22,000,000 francs (\$4,400,000), and temporary barges will be built at other points to provide for immediate needs. Some of the plans are being drawn up, and in some cases the work is on the point of being started.

But this is not all, for since 1910 the city has been taking measures not only to repair the damage done then but also to provide against future trouble. For instance, urgent work has been done on pavements, water piping and sewers. Special attention has been given to the sewers, which were one of the great causes of damage during the 1910 inundation, and 6,000,000 francs (\$1,200,000) have already been expended on this work alone. On the other hand, the metropolitan subway has laid out more than 5,000,000 francs for repairing damages and for consolidation work. For the city sewers, gates are placed where they empty into the river, to prevent backing up of water. The police department has now organized a system of mobilization which allows of bringing help to all the threatened points along the river at the same time at the first alarm. Appreciable results, stated M. Dausset in closing, have already been obtained from the \$4,000,000 spent.

ABSORBING WELLS

The Paris daily press published an account of a series of experiments which the municipality was engaged in to secure protection against inundations. Shortly after the great flood of 1910 the Municipal Council had its attention called to the method of absorbing wells for taking off the water of the stream. A system of the kind had, it appears, been already put into successful use by a large landowner in the Poitou region who was at the same time an experienced engineer. Thereupon M. Dausset of the Municipal Council desired to promote the system on account of the great economy which it gave. However, Engineer Bergeron, whom the inundation commission retained to look into the matter, reported against it. The matter was not dropped, and Messrs. Dausset and Beauchamp had the technical commission make a visit to the spot; as a result of which the commission expressed itself favorable to the idea.

Later on M. Dienert, chief of the city

water inspection service, made some experiments which furnished information relative to the absorbent-well method in the region of Paris. He had three test wells put in on the Romainville plateau, in the Loing valley and the Grand Morin valley, and these appear to give quite conclusive results. In his report to the municipality M. Dienert states that the method of using the soil as a reservoir for surplus water is likely to have a great influence on the amount of inundation. There are some extensive regions in the Seine basin which are very well adapted for the application of this method. Still more striking is the fact M. Dausset demonstrates in this report, taking the basin of the Marne, a confluent of the Seine above Paris, as an example—that if in this basin alone there had been carried out the proper work with a system of absorbent wells for drainage the output of the river would have been diminished by at least 500 cu. m. per second (15,000 sec.-ft.), and this would lead to a reduction in the Seine level at Paris of 1 m., which is a remarkable result. He therefore concludes that proper attention should be paid to such an important idea, for such work can be carried out within a comparatively short time in order to reduce the amount as well as duration of the freshets. On the contrary, the extensive operations which the municipality is planning for the Seine will mean several years' work and cannot be commenced before much time is spent in preliminary plans.

[The foregoing article by Mr. Mann was received before the outbreak of the European war. It is probable that the war situation will result in indefinite postponement of the flood-prevention work contemplated.—EDITOR.]

A BUILDING-HEIGHT restriction law has been passed in Minneapolis, as reported in the Current News of this journal Aug. 8. A maximum height of 170 ft.—twelve stories—is specified. Only one building in the city has a height greater than this.

Removing Panels Bodily from a Concrete Wall

Done in Connection with Extension of Municipal Car Barns in San Francisco

IN the work of extending municipal car barns in San Francisco it was recently necessary to take out the panels in an 8-in. concrete wall at the north end of the building, so as to give free access to the addition built on the north side. As considerable excavation had to be done below the footings of the old wall, it was decided that it would be cheaper to take the panels out before the excavation had gone much below the floor level of the old structure, and thus after their removal it would be possible to complete the excavation and, without interference from above, substitute temporary timber footings and pour new foundations.

Accordingly, the breaking out of the old wall was commenced while the excavation was in progress, and to expedite matters—for there was a bonus of \$250 per day for the early completion of the contract—the panels were cut out around the edges by pneumatic drills, thrust out bodily by hydraulic jacks and then broken up.

Eight panels in all were taken out; of these six were 19 ft. high by 26 ft. wide, while two were 17 ft. high by 23 ft. wide. The panels were first cut entirely through on three sides by the drills, the reinforcing being cut by hacksaws, and then a line of drill holes was made along the bottom of the panel to insure its breaking along the floor line. The bottom line, however, was considered to be unnecessary and was omitted after the first few panels were removed, with the result that the break occurred along the same line as before. The jacks were worked against a 14 x 14-in. timber braced against the top of the panel to be broken out.

The work is being done by James L. McLaughlin, general contractor, and is under the personal supervision of D. Nordstrom.



REMOVING CONCRETE PANELS FROM SAN FRANCISCO CAR-HOUSE WALL

Deep-Water Concreting through a Tube

Notes on the Tremie Method and Suggestions of Various Expedients to Avoid the Difficulties Likely to Be Encountered

By E. B. VAN DE GREYN
Denver, Colo.

SOME time ago in a short article in the *Engineering Record* on a method of starting deep-water concreting through a tube it was stated that, "as is well known, unless the tube is sealed in some way the cement will wash out during the downward passage and leave only a pile of stone and sand. This waste of concrete may in the case of a 12-in. tube 50 ft. long amount to more than 1 cu. yd."

It is plain that if the tube is filled by dumping little batches (such as wheelbarrow loads) the concrete in each small batch will be washed until the water in the tube is absorbed or forced out at the top. If, however, a large batch of concrete, sufficient to fill a considerable length of the pipe, say 30 or 40 ft., is dumped at one time into the hopper of the tremie I would not expect the concrete to be washed as stated above—that is, if the procedure of charging outlined hereafter is followed.

EXPERIMENTAL TREMIE

A laboratory experiment with a miniature tremie was tried by the writer. The tremie consisted of a glass tube 1 in. in inside diameter and 12 in. long and a tin funnel cut to fit the top. A china plate was placed in the bottom of a water bucket partly filled with water. The glass tube was clamped to a standard with its lower end 5 in. below the water surface and $\frac{3}{8}$ in. above the china plate. A batch of mortar was made up of 1 part of cement and 2 parts of standard Ottawa sand, the mortar being made quite wet so as to flow freely through the tube. The batch of mortar was dropped into the hopper several times with the same results. In each case the water was driven out of the tube ahead of the mortar and the mortar spread out over the plate and filled the lower part of the tube. In each case there was no washing out of cement. The mortar extended about 5 in. up in the tube. A depth of water of 5 in. is small compared with 40 or 50 ft., but the experiment shows what might be expected.

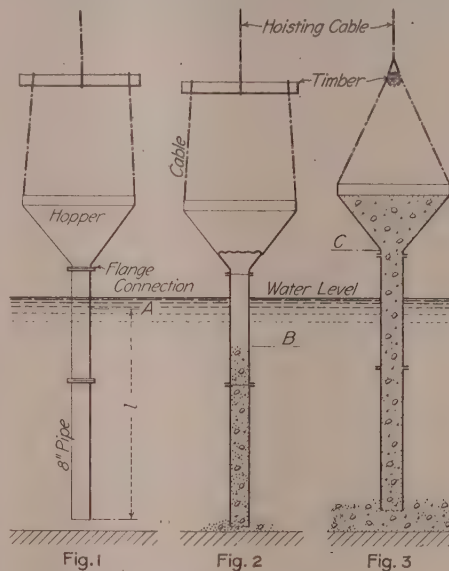
SEALING THE PIPE

There is no doubt that preliminary sealing of the pipe in some way is the safe way to proceed to charge the pipe for the first time. Under certain conditions of concreting under water I would consider that a layer of shavings and sawdust with a layer of cement on top should be placed in the pipe before starting the concrete, but in some instances the plug might be dispensed with. For example, consider the conditions on one job under the writer's charge. A large open caisson had been sunk to a depth of about 50 ft. below water level in alluvial soil, the caisson had been dredged out and piles driven within, and finally the soil that was forced up during driving had been removed. The excavation was carried a little lower than depth required on the plans. The concrete placed immediately on the bottom would mix with the mud and form a base for the remaining concrete required on the plans, and due to the large mass of concrete to be placed in the caisson it was not necessary often to change the position of the

tremie in a horizontal direction. Under such conditions I believe charging the tremie according to the method outlined below was ample protection against washing out of the cement.

The following method of deep-water concreting has been used under the charge of the writer: Inspection after pumping out the water has always revealed the top concrete to be first class. The method and equipment, together with precautions to be observed, are submitted with the hope that some of the ideas may be of benefit to those who may find themselves for the first time in charge of such work.

A tremie is shown in Figs. 1, 2 and 3 made up of sections of water pipe with bolt-



TREMIE EMPTY, SEALED, AND READY TO BE RAISED

ed flange connections and a metal hopper large enough to hold one batch of concrete. The hopper is bolted to the top section of the pipe. All connections are made watertight by means of gaskets. An 8-in. pipe has proved practicable and has the advantage over larger pipe in being lighter. The view shows a tremie used on the city waterway bridge at Tacoma, Wash. The International Contract Company was the contractor, Waddell & Harrington were the consulting engineers representing the city and the writer was resident engineer for Waddell & Harrington. The same tremie was used on the Puyallup River bridge at Tacoma.

On one job the tremie was raised and lowered with the hammer line of the pile driver stationed on falsework over the caisson. This proved very satisfactory, as the up-and-down movement of the tremie was under perfect control, and such control is important in tremie work. On another job the tremie was suspended from the load line of a barge derrick. This proved serviceable, but not so satisfactory as the pile driver because of swaying of the tremie due to wave action on the barge, and due to tipping of the barge at the time of raising the tremie.

In charging the tremie a large batch capable of filling a considerable length of the pipe should be discharged into the hopper at one time. At Tacoma the concrete was discharged from the mixer into a concrete bucket and the concrete bucket swung over the hopper of the tremie by a derrick. Where the contractor is not equipped with a derrick a contractor's concrete cart holding a large enough batch could be used, or if wheelbarrows are used a hopper with a trap door would serve the purpose of discharging a large batch suddenly into the tremie hopper. After the pipe is once sealed the concrete from then on can be dumped into tremies in large or small batches.

CONCRETE SHOULD BE MUSHY

Concrete deposited in deep water through a pipe should be of a mushy consistency in order that it may flow easily after leaving the end of the pipe under the surface of concrete just previously deposited; it will then spread more evenly after leaving the pipe, thus avoiding the formation of hillocks and making it unnecessary to change the position of the tremie in a horizontal direction as frequently as would be the case if drier concrete were used. Also, it will not choke the pipe. A little experimenting at the outset will soon indicate how much water should be used in each batch. After the proper amount is determined it should be regulated by a gage so as not to vary, consideration being given, of course, to appreciable changes in the amount of moisture in the aggregate.

Mushy concrete deposited in water should have an excess of cement. There is a loss of cement due to the excess water in the concrete finding its way out, carrying a portion of the cement, which is found in the laitance on top. A 1:2:3 mix is recommended; this is the mix specified by Waddell & Harrington for mass concrete deposited under water through a pipe.

OPERATION

In the illustration Fig. 1 shows the tremie ready to receive the first batch, the bottom of the pipe being raised from 6 to 12 in. above the bottom of the excavation, so that the water may escape as the concrete comes down the pipe. It is well to land the pipe on the bottom and then raise it so that one is assured that it is above the bottom. Assume that one batch would fill the pipe for a length l , that is, when the concrete begins to emerge from the end of the pipe the top surface is at level A. If the pipe is to have a plug of planer shavings and cement they should be in place before dumping concrete into the pipe. Charging the pipe is the most difficult part of deep-water concreting through a tube, hence it should be supervised by some competent person. If the pipe is dropped before concrete emerges from the lower end the water in the lower part of the pipe cannot escape and it boils up through the concrete, washing out the cement. Whether a new charge or the absorption of this water by additional drier concrete is better must be determined by judgment, and the amount of such water should decide which will result in the lesser waste. If the dropping of the pipe in making the first charge is delayed too long all the concrete escapes, which means that one batch is partly lost and the operation must be repeated. After the batch is dumped into the hopper, when the surface of the concrete drops to level A, the tremie should

be dropped. By the time the pipe is dropped to the bottom the surface of the concrete will be below level A, as indicated in Fig. 2, and the tremie will be sealed.

After the pipe is sealed with concrete as shown in Fig. 2 the remainder of the pipe and hopper can be filled as shown in Fig. 3. Next the tremie should be raised slowly until the concrete flows downward. It is not safe to raise the pipe continuously until the concrete begins to flow, because by the time the "stop" signal is obeyed the pipe will have been raised too far and there will be a sudden rush of concrete through the pipe, with accompanying danger that the pipe will not be lowered quickly enough to prevent all concrete from leaving the pipe and leaving it unsealed. Therefore the tremie should be raised a few inches and held, and then raised again a few inches and held, repeating until the correct vertical position is found where downward movement will begin; the concrete will then slowly lower in the pipe and will emerge from the bottom under right conditions. All this can generally be done in short time and will cause no delay at the mixer, especially after the men become familiar with the work. When the surface of the concrete lowers to some level, say C, at which it is desired to stop the flow, the tremie is lowered and the flow ceases. There is some definite point at which the pressure on the end of the pipe due to head of water and concrete outside of the pipe plus the resistance of the concrete to move through the pipe is equal to the weight of the concrete. It is to locate this point that the tremie should be raised a little at a time as described in the foregoing. Concrete can thus continue to be placed under water without passing through water, avoiding all wash, emerging as it does from the pipe under the surface of the concrete just previously placed. It is well never to let the surface of the concrete go below the bottom of the hopper, since it is then always in sight; if it is allowed to go below this the next batch confines the air in the tube, most of the air bubbling up through the concrete.

PRECAUTIONS

See that all connections are watertight. Lash the several sections of the pipe together with cable so as to be able to save them if they break loose. Examine the connections whenever possible to see that they are not broken. If a connection were broken and the break large enough to let concrete through great damage would result by concrete flowing through the break and dropping through the water, causing segregation of the constituent materials. After starting concreting keep it up continuously until completion and regulate the moving of the tremie horizontally so as to keep the laitance on top where it can be removed later. After the water is pumped out, clean the surface of the concrete thoroughly so as to remove all laitance and furnish a good surface on which to start other concrete work.

There appeared in the Engineering Record of June 6, page 643, an interesting and instructive article by R. C. Miller on the tremie method of concreting in deep water in connection with building the new Pennsylvania bridge over the Maumee River at Toledo. In view of the similarities and differences in experience on that job and work done under the writer's direction a discussion of some of the methods used at Toledo may be of value.

As described by Mr. Miller, there was used on the experimental pier a 14-in. tremie with a 1/2-yd. receiving hopper, the hopper being fed from a 15-in. delivery pipe leading from another receiving hopper, which in turn was fed by a 3/4-yd. bucket from the 1-yd. mixer. It was stated that the pipe, when filled with concrete, would not free itself until the end had been pulled nearly out of the concrete previously deposited and that when it did start it went with a rush, the quick release of the load at the instant of starting causing the derrick boat to fall back from its tipped position and lift the pipe clear of the concrete, with resultant loss of the charge and filling of the pipe with water. Also, in attempting to "drown out" or absorb the water in the pipe the concrete overflowed the hopper and backed up in the delivery pipe. Later a 20-in. tremie pipe with a 1-yd. hopper was used and the difficulties, though not entirely overcome, were greatly decreased, the laitance deposit being reduced to 2 or 3 in.

EIGHT-INCH PIPE AMPLE

In the first case—that is, where the 14-in. pipe was used—it occurs to the writer that the difficulties were occasioned by the following things: First, since this kind of work has been done successfully with an 8-in. pipe lack of sufficient water in the concrete will probably explain why the concrete would not flow until the end of the pipe was pulled nearly out of the concrete previously deposited. A dry concrete would flow with difficulty through the pipe, and the concrete previously deposited, being also not wet enough, would require more applied force to cause it to be displaced, thus adding to the difficulty. Second, in raising the pipe with the barge derrick it was probably not raised a little at a time as recommended above, so that the tremie was not properly controlled in its vertical movements. Third, when the charge was lost and the pipe filled with water it appears from Mr. Miller's article that effort was made to free the pipe of water by pouring concrete into it and not by charging it with a large batch suddenly dropped into the hopper. This seems to be borne out by the description of the equipment, which showed a 15-in. delivery pipe feeding the concrete into the tremie hopper. Pouring concrete into the pipe when filled with water would cause a washing of the concrete and a separation of the constituent materials. Also, when the concrete overflowed the hopper it caused a loss of concrete and added to the amount of laitance deposit.

DISADVANTAGES OF LARGE PIPE

The use of a large pipe, 20-in., for example, occasions certain difficulties. It is hard to handle, and trouble is also found in charging such a pipe the first time. Assume that a 1-yd. batch is used. Such a batch would fill about 12 1/2 lin. ft. of a 20-in. pipe. Where the water is deep the surface of this plug of concrete would be at a considerable depth when its lower end emerged from the bottom of the pipe, and the pipe would then have to be dropped very quickly or the plug would leave the pipe entirely and let it refill with water. With a 12-in. pipe the plug would be about 34 ft. long and the time at which the pipe should be dropped could be better judged, since the surface of the concrete plug would be nearer the hopper and more time would be allowed for dropping it. Thus it is seen that so far as charging is concerned, assuming

that the concrete is of right consistency, the smaller pipe is less liable to loss of charge and is under better control.

The major part of the laitance deposit on the Toledo work appeared to be due to spilling of concrete and washing of concrete when it emerged from the end of the tremie as it was lifted clear of the concrete previously deposited. Such laitance should form a comparatively small part of the total laitance formed.

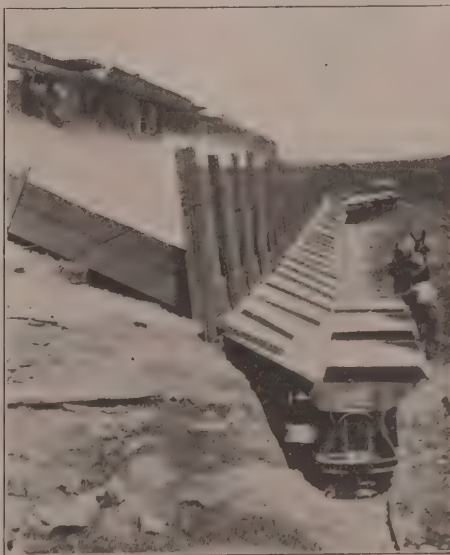
The recommendations of Mr. Miller as to the use of several tremies which would not need to be moved horizontally but only vertically and would be under absolute control as to vertical movement should unquestionably be followed where possible. If such a method is used the quantity of laitance will be due mainly to that formed by the upward movement of the excess water in the concrete through the concrete deposited, such water carrying to the surface the very fine material.

Use of Prison Labor in Building Illinois Highways

Sixty Convicts Work Harmoniously and Make No Attempt to Escape—Materials Handled on Narrow-Gage Track Along Road

SIXTY convict laborers are being used by the Illinois State highway department to build 12 mi. of waterbound macadam highway near Beecher, Ill., and are proving, according to the engineers in charge, as good as, if not better than, labor that could be obtained from the Chicago labor agencies in so far as the ordinary work of shoveling and loading material is concerned.

The men are on their honor, and although they have been convicted of everything from petty larceny to murder, not an attempt to escape has been made to date. Tent sleeping quarters, with wooden floors, iron beds and bedding are furnished, there being two men to a tent. Meal hours are set at a definite time and the men are expected to quit work and report on the minute. Plain but wholesome food is cooked in the big kitchens. The men are credited with 50 cents a day straight time. A large bathhouse, with a constant supply of hot water on hand, has been erected. The men have a 9-hr. working day and do not work Saturday afternoons or Sundays. A camp



DELIVERY SYSTEM FOR LOADING CARS

superintendent and one night assistant have charge of the men.

Owing to the long haul a narrow-gage industrial railroad has been built, on which stone, screenings and binder can be hauled from the bins to any point along the road. A crew of four, consisting of engineman, head and rear brakemen and a trackman, operates the train. The head brakeman rides in the engine cab and assists in firing. The trackman is used to assist in dumping the cars. At present two trains of 20 Koppel cars each are used, and the trains will soon be increased to thirty cars. Crushed stone and screenings are obtained, free except for freightage, from the State penitentiary at Joliet. The bonding gravel, which has a 10 per cent loam content, is purchased. Material is shoveled from the railroad flat cars directly into a triangular bin with small gateways, which are opened when the industrial cars are filled.

Rough grading to within 6 in. of the final grade is done by the local highway commissioner with outside labor. It is to be noted that his men have a 10-hr. working day. C. M. Hathaway is the assistant engineer from the State highway department in charge of building the road. N. T. S. Ashkins and Floyd Little are his assistants.

Paris Contemplates Additional Water Supply

IT has been reported in the Paris daily press that the municipality intends to decide at a no very distant date upon the project of securing an additional water supply at a great distance, going even as far as Lake Leman. The municipality in fact gave power to M. Guillard to treat with the Seine Department regarding the different sources of potable water available for city use. The report drawn up recently by the Seine Department is soon to be presented to the City Council for consideration. This report bears on the question of securing a water supply from the Loire valley, and also considers the Perche region, Normandy, and Lake Leman, which, it will be remembered, lies partly in Switzerland and partly in France. But before presenting the project definitely before the city the Seine Department desires to have the best guarantee as to the good quality of the water. It will, therefore, take the proper measures in this behalf, among others having the matter brought before the water-supply surveillance commission, of which Dr. Roux, of the Pasteur Institute, is president.

INFLAMMABILITY of creosoted wood and the danger that may attend its use are illustrated by the recent destruction by fire of the Kingston dock, Glasgow. New wharfs were being constructed of heavily creosoted wooden piles, which were set on fire by a workman inserting a hot iron to clean out a newly bored hole. The flames spread with great rapidity and caused the destruction of the piling and the consequent collapse of the fronts of the adjacent quays and the fall of the steel dockheads and cranes. The elimination of creosoted wood in the rebuilding of the piers is considered because it is thought that new piling in hot weather may be ignited even by accidental proximity of service pipes or hot materials. The use of interlocking steel piles is proposed as an alternative.



DOUBLE-SHELL WALLS AT CHICAGO & WESTERN INDIANA RAILROAD CROSSING

Time and Cost Saving with Movable Forms

Chicago, Rock Island & Pacific Reduces Time Element 75 Per Cent and Cost 70 Per Cent in Erecting Large Retaining Walls

BY use of movable forms the Chicago, Rock Island & Pacific Railway has cut the cost of erecting its straightaway retaining walls on Chicago track-elevation work 70 per cent and has reduced the time element 75 per cent as compared with the former method of using stationary forms. Both steel and wooden forms are employed. The steel forms are said to be the largest forms for retaining walls that have ever been built.

Before the movable forms were used it took four days to build stationary forms of corresponding capacity, and a proportionate delay and expense was incurred. Now a 24-ft. section of wall is poured and set in

24 hr., the forms being kept in place 12 hr. after filling.

In connection with the wooden forms, two are used, one having bulkheads and the other being side forms only. The walls are made in alternate sections by the bulkhead form, the other form simply lapping its side forms over the alternate sections and thus saving the cost of having bulkheads, and also the trouble of lining in. The form sides are suspended from a gallows frame which runs along rails placed on each side of the form. The gallows frame is made of 12 x 12-in. timbers with 3 x 8-in. bracing. The rear side form is held to the gallows frame by means of short wooden struts, while the stepped form is attached by means of pulleys. Each bulkhead is made up of a series of seven sheets. When the form is moved ahead it is, of course, necessary to strip one end. The horizontal tension stresses are taken by rods fastened on the outside of the form sheet with Universal form clamps. Six-way multiple ducts for wiring are embedded near the top of the wall.

In connection with the steel forms rods inserted in tin speaking tubes are used to take the tension and hold the forms together, the rods being fastened at either end with Universal form clamps. When the form is moved the rod is withdrawn with the aid of the clamp and the tube left in the concrete, the use of tubing having been found greatly to facilitate operations.

WALLS REST ON CONCRETE PILES

Due to the excessive heights of the walls, concrete piles are used. About 350,000 lin. ft. of 16,000 Raymond concrete piles had been driven to July 15. The safe bearing power figured by the "Engineering News" formula was found to be 43 tons. Tests have also been made at various times and the loading kept within a safe limit. Loads placed on each pile range from 21 to 25 tons. The piles were driven to a penetration of four blows to the last inch with a Vulcan hammer weighing 5000 lb. and having a 36-in. stroke.

The walls are made in 24-ft. sections with the wood forms and 35-ft. sections with the steel forms and range in height from 26 to 40 ft. above their concrete slab footings,



STEEL FORM AND MOVABLE FRAME

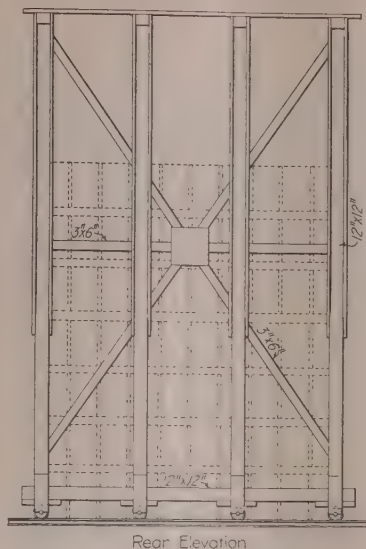
which vary, according to the height, from 4½ to 6 ft.

MIXING EQUIPMENT

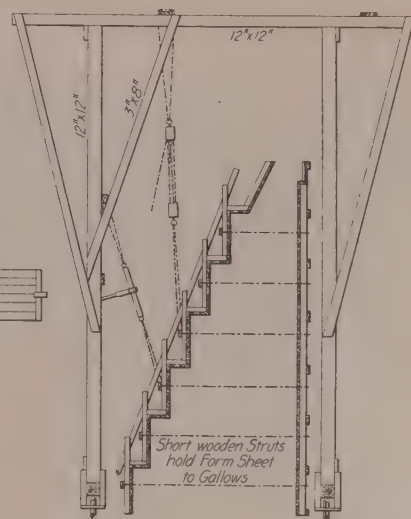
Parallel with the wall line and within a few feet of it a temporary standard-gage track is used on which to haul the mixing equipment. The latter consists of four flat cars. The first car carries a 1-yd. Smith mixer, the second a frame supporting a bin, which has two measuring boxes in the bottom; the third and fourth cars contain sand and cement respectively. The boxes on car 2 were designed to hold 0.8 yd. of stone, the quantity used in a 1-yd. batch of 1:3:5 mix. The boxes are controlled by levers, and while one box is discharged, the other is filling up. The sand car has a similar arrangement, but uses measuring boxes designed to hold 0.48 yd. A 270-ft. belt 24 in. wide traverses the center line of the cars from the front of the cement car under the spouts to the mixer. In making a batch, four and one-half bags of Universal Portland cement are placed on the belt. When the cement reaches the next car the correct amount of sand is poured over the cement and the mix carried on to the stone car for the proper portion of stone and thence to the mixer. The quantities used were based on a well-graded mixture having 35 per cent voids. The capacity of the mixer is 60 yd. per hour, but the maximum run to date has been 80 yd. in 85 min. From the mixer the batch is discharged into the bucket of a concrete tower built by the T. L. Smith Company from the designs furnished by the track-elevation department of the Chicago, Rock Island & Pacific Railway.

SHELL WALL

Double 40-ft. shell walls resting on concrete piles were built at a crossing with the Chicago & Western Indiana Railroad, as that particular design of wall gave a greater clearance at the foot, and space was desired in which to run a temporary track for the latter railroad. The economy of the design of this wall is shown by the accompanying sectional drawing. As a richer mix was necessary, a 1:2:4 was used. The cutting down of the mass of

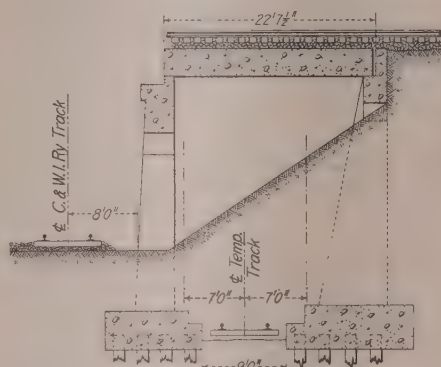


Rear Elevation



Cross Section

DETAILS OF TRAVELING CONCRETE FORMS FOR BUILDING RETAINING WALLS



SECTION OF SHELL ABUTMENT WALL

the concrete gave a smaller bearing pressure, and not as many piles were needed under this type of wall.

The steel forms were designed and built by the Blaw Steel Construction Company, of Pittsburgh. The wooden forms owe their inception to the Rock Island track-elevation department, by which they were designed and constructed.

Motor-Driven Pumps at Beardstown, Illinois

Variable Pump Speeds Obtained by Using Pulleys of Three Different Sizes

SPEED variations of motor-driven centrifugal pumps in the new station of the Coal Creek Drainage and Levee District, 3½ mi. south of Beardstown, Ill., are accomplished by having on hand three sizes of pulleys for lifts during low, normal and high water in the river. The station replaces a steam plant installed eleven years ago to reclaim 6700 acres of corn-and-wheat Illinois River bottom land. It comprises three No. 20 American pumps of 12,000-gal. per minute normal capacity, belt-connected to 2200-volt, 100-hp. General Electric motors operating at 865 r.p.m. and housed in a 40 x 60-ft. building of concrete plastered on expanded metal.

Suction and discharge pipes of all pumps are flared out from 22-in. to 26-in. riveted steel pipe. The discharge is 125 ft. long, rises 15 ft. in a siphon over the levee and is sealed at the outlet at all river stages. The three lines are suspended from pile-trestle bents by U-bolts.

No valves are placed on the discharge lines and priming is accomplished by exhausting the air from the high point on top of the levee, a 3-in. covered air line connecting to a 12 x 12-in. Marsh vacuum pump belt-connected to a 10-hp motor. Immediately beyond the exhaustor the line is carried up in an inverted U to a point 37½ ft. above extreme high water for the purpose of preventing water entering the exhaustor. The engineer was, however, somewhat surprised to find water rising over the U, apparently greater heights than those equivalent to a perfect vacuum. Beyond the outgoing leg of the U a valve was placed on each of three pipes leading to the respective discharge lines on the level. The action of closing one valve trapped some water in the leg of the U, and upon opening another valve the air behind this valve made an air-lift pump of the combination, the air forcing the plug of water ahead of it into the exhaustor. Tapping the pipes on the exhaustor side of the valves and running a drain pipe 33 ft. long to the sump obviated further difficulty.

At the station the low-water river level is at El. 85, high water is at El. 100 and the ditch at El. 79. The center of the pump is



BUILDING WALL IN ALTERNATE SECTIONS WITH TWO TRAVELING WOODEN FORMS

at El. 86. For static heads from 8 to 16 ft. a 17-in. pulley for the motor is used; from 16 to 24 ft., a 19½-in. pulley, and from 21 to 24 ft. a 22-in. pulley is provided. For the purpose of taking up the slack in the belts the motors are set on slide rails bolted to timbers embedded in the concrete. In one or two years out of ten it will be unnecessary to change from the small pulley and only in one year out of ten will the largest pulley be needed. By these changes and by operating one, two or three pumps the efficiency curve can be kept fairly well above the 70-per cent points at both ends of the curve, which rises to a maximum of 76 per cent.

Formation in winter of a thin film of ice on the interior of the pump in the small clearance between runner and casing after breaking the vacuum and draining out the casing caused some difficulty in starting last spring.

Current to operate the motors is furnished by the Public Service Company, of Beardstown, which obtains a portion of its supply from the Mississippi River Power Company at Keokuk.

W. T. McCaskey, of Chicago, was the contractor for the pumping station, and Robert W. Hunt & Company were the consulting engineers, H. S. Bowen being assistant engineer in charge of design and construction.

Transportation of Débris by Water

Summary of Experiments Made to Determine the Laws Controlling the Carriage of Particles Moved Along the Stream Bed

PROFESSIONAL PAPER 86, just issued by the U. S. Geological Survey, is a formidable volume of 260 pages, 9 x 11½ in. in size, devoted to a description and discussion of experiments on the transportation of debris by running water made by G. K. Gilbert, assisted by E. C. Murphy. The work was done in a flume erected at the University of California, at Berkeley. The object of the experiments was to learn the laws which control the movement of bed load—not of material in suspension—and especially to determine how the quantity of load is related to the stream's slope and discharge and to the degree of comminution of the debris. The author of the paper, Mr. Gilbert, states that while an advance was made the goal was not reached.

The following abstract (practically in full) forms the introductory chapter of the volume:

METHOD

Experiments were performed in which each of the three conditions—stream slope, discharge, and degree of comminution—was separately varied and the resulting variations of load were observed and measured. Sand and gravel were sorted by sieves into grades of uniform size. Determinate discharges were used. In each experiment a specific load was fed to a stream of specific width and discharge, and measurement was made of the slope to which the stream automatically adjusted its bed so as to enable the current to transport the load.

For each combination of discharge, width, and grade of debris there is a slope, called competent slope, which limits transportation. With lower slopes there is no load, or the stream has no capacity for

load. (Capacity is defined for the purposes of this paper as the maximum load of a given kind of debris which a given stream can transport.) With higher slopes capacity exists; and increase of slope gives increase of capacity. The value of capacity is approximately proportional to a power of the excess of slope above competent slope. If S equal the stream's slope and σ equal competent slope, then the stream's capacity varies as $(S - \sigma)^n$. This is not a deductive but an empiric law. The exponent n has not a fixed value but an indefinite series of values depending on conditions. Its range of values in the experience of the laboratory is from 0.93 to 2.37, the values being greater as the discharges are smaller or the debris is coarser.

OTHER FACTORS

For each combination of width, slope, and grade of debris there is a competent discharge, κ . Calling the stream's discharge Q , the stream's capacity varies as $(Q - \kappa)^o$. The observed range of values for o is from 0.81 to 1.24, the values being greater as the slopes are smaller or the debris is coarser. Under like conditions o is less than n ; or, in other words, capacity is less sensitive to changes of discharge than to changes of slope.

For each combination of width, slope, and discharge there is a limiting fineness of debris below which no transportation takes place. Calling fineness (or degree of comminution) F and competent fineness ϕ , the stream's capacity varies with $(F - \phi)^p$. The observed range of values for p is from 0.50 to 0.62, the values being greater as slopes and discharges are smaller. Capacity is less sensitive to changes in fineness of debris than to changes in discharge or slope.

Most of the experiments were with straight channels. A few with crooked channels yielded nearly the same estimates of capacity. The ratio of depth to width is a more important factor. For any combination of slope, discharge, and fineness it is possible to reduce capacity to zero by making the stream very wide and shallow or very narrow and deep. Between these extremes is a particular ratio of depth to width, ρ , corresponding to a maximum capacity. The values of ρ range, under laboratory conditions, from 0.5 to 0.04, being greater as slope, discharge, and fineness are less.

VELOCITY AND MIXTURES

The velocity which determines capacity for bed load is that near the stream's bed, but attempts to measure bed velocity were not successful. Mean velocity was measured instead. To make a definite comparison between capacity and mean velocity it is necessary to postulate constancy in some accessory condition. If slope be the constant, in which case velocity changes with discharge, capacity varies on the average with the 3.2 power of velocity. If discharge be the constant, in which case velocity changes with slope, capacity varies on the average with the 4.0 power of velocity. If depth be the constant, in which case velocity changes with simultaneous changes of slope and discharge, capacity varies on the average with the 3.7 power of velocity. The power expressing the sensitiveness of capacity to changes of mean velocity has in each case a wide range of values, being greater as slope, discharge, and fineness are less.

In general, debris composed of particles of a single size is moved less freely than debris containing particles of many sizes. If fine material be added to coarse, not only is the total load increased but a greater quantity of the coarse material is carried.

MODES OF TRANSPORTATION

Some particles of the bed load slide; many roll; the multitude make short skips or leaps, the process being called saltation. Saltation grades into suspension. When particles of many sizes are moved together the larger ones are rolled.

When the conditions are such that the bed load is small, the bed is molded into hills, called dunes, which travel downstream. Their mode of advance is like that of eolian dunes, the current eroding their upstream faces and depositing the eroded material on the downstream faces. With any progressive change of conditions tending to increase the load, the dunes eventually disappear and the debris surface becomes smooth. The smooth phase is in turn succeeded by a second rhythmic phase, in which a system of hills travels upstream. These are called antidunes, and their movement is accomplished by erosion on the downstream face and deposition on the upstream face. Both rhythms of debris movement are initiated by rhythms of water movement.

While the principles discovered in the laboratory are necessarily involved in the work of rivers, the laboratory formulæ are not immediately available for the discussion of river problems. Being both empiric and complex, they will not bear extensive extrapolation. Under some circumstances they may be used to compare the work of one stream with that of another stream of the same type, but they do not permit an estimate of a river's capacity to be based on the determined capacities of laboratory streams. The investigation made an advance in the direction of its primary goal, but the goal was not reached.

LOAD VERSUS ENERGY

The energy of a stream is measured by the product of its discharge (mass per unit time), its slope, and the acceleration of gravity. In a stream without load the energy is expended in flow resistances, which are greater as velocity and viscosity are greater. Load, including that carried in suspension and that dragged along the bed, affects the energy in three ways: (1) It adds its mass to the mass of the water and increases the stock of energy pro rata. (2) Its transportation involves mechanical work, and that work is at the expense of the stream's energy. (3) Its presence restricts the mobility of the water, in effect increasing its viscosity, and thus consumes energy. For the finest elements of load the third factor is more important than the second; for coarser elements the second is the more important. For each element the second and third together exceed the first, so that the net result is a tax on the stream's energy. Each element of load, by drawing on the supply of energy, reduces velocity and thus reduces capacity for all parts of the load. This principle affords a condition by which total capacity is limited. Subject to this condition a stream's load at any time is determined by the supply of debris and the fineness of the available kinds.

In the experiments described above—experiments illustrating stream transporta-

tion—the load traversed a plastic bed composed of its own material. Other experiments were arranged in which the load traversed a rigid bed, the bottom of a flume. Capacities are notably larger for flume transportation than for stream transportation, and their laws of variation are different. Rolling is an important mode of progression. For rolled particles the capacity increases with coarseness, for leaping particles with fineness. Capacity increases with slope and usually with discharge also, but the rates of increase are less than in stream transportation. Capacity is reduced by roughness of bed.

VERTICAL VELOCITY CURVE

The vertical distribution of velocities in a current is controlled by conditions. The level of maximum velocity may have any position in the upper three-fourths of the current. In loaded streams its position is higher as the load is greater. In unloaded streams its position is higher as the slope is steeper, as the discharge is greater, and as the bed is rougher.

The constant of the Pitot velocity gage—the ratio between the head realized and the theoretic velocity head—is not the same in all parts of a conduit, being less near the water surface and greater near the bottom or side of the conduit.

Waterproofing Reservoir Floor

Procedure at St. Louis Water Clarification Plant to Eliminate Leakage in Basin 9

ALTHOUGH a cutoff wall of United States steel sheet piling had been driven along the north edge of the division wall, which was described in the Engineering Record of May 24, 1913, page 585, between basins 8 and 9 of the water-clarification plant at St. Louis, this, states E. E. Wall, water commissioner, did not stop the leakage into basin 8 when basin 9 was full. It did prevent blowouts under the wall. Leakage tests were run on basins 8 and 9 before draining, and after basin 8 was lowered to within several feet of the bottom the mud coating was examined to find the location of possible leaks. Many small ones were found scattered over the basin bottom. This, in connection with the seepage under the division wall, indicated clearly



AGGREGATE DUMPED DIRECT FROM CARS INTO BASINS BEING WATERPROOFED

that leakage could not be prevented by patching but that a general waterproofing of the entire bottom was desirable. After examining into the merits of the various systems it was decided to level up all surface inequalities, apply a waterproofing made up of six layers of Barrett pitch and five layers of 14-lb. tarred wool felt, and protect the waterproofing by a 3-in. layer of concrete laid in blocks 8 ft. wide by 16 ft. long, breaking joints with the 8 x 8-ft. blocks of the basin floors as originally laid, with joints between the blocks $\frac{1}{2}$ in. wide. The joints were filled with asphalt.

The layers of felt were carefully rolled over the surface and coated with hot pitch, all being thoroughly cemented together. The concrete was 1 part cement, 3 sand and 6 gravel and was finished to a smooth surface, an average of 2 quarts of mortar being used to each block. At the ditch the concrete on the sloping sides was reinforced with expanded metal wired to $\frac{5}{8}$ -in. reinforcing rods and anchored in the old concrete. The asphalt used in filling the joints was one with high ductility and penetration. The average cost per square was \$11.08.

The basins, built on the alluvial river bottom, have bottoms of concrete 9 in. thick laid over 18 in. of puddle. Underlying the puddle is gumbo and quicksand to a depth of about 30 ft. A steel sheet-piling curtain wall along the river side of the basins extending to rock prevents much movement of the sand, and the application of a similar waterproofing to basins 7 and 8, the report states, will stop the leakage, which has been a source of trouble since the basins were built in 1907.

Waterproofing of basin 9 was completed by the Herman Construction Company, contractor, early in September, and the basin was put into service as a clear-water storage basin in December.

Concrete Headframe for Mine

THE No. 1 vertical shaft at the Perseverance mine of the Alaska Gastineau Mining Company has a total depth of 1544 ft., and the shaft collar is near the mountain summit, at an altitude of 2300 ft. above sea level. Because the shaft heads on a steep hillside where there is an extremely heavy snowfall, according to the "Mining and Scientific Press," a steel-and-concrete headframe about 75 ft. high was designed to provide a safe margin for overwinding and to resist the snow slides that often occur at this point.

At a depth of 905 ft. the shaft is intersected by a cross-cut where the main hoist is located, and by means of which all lumber for forms, cement and sand were hoisted up the shaft to the surface where the headframe was built. The rock was taken from the hillside above the site and washed before using. A small mixer driven by a gasoline engine was brought up the shaft, and this supplied 1:3:5 mix, which was wheeled along a scaffold and dumped into the forms.

The walls of the headframe decrease from a thickness of $2\frac{1}{2}$ ft. at the base to 1 ft. at the top. The reinforcement consisted of old 12-lb. rails and worn hoisting cable. After the concrete had set the forms were removed and a wide rock wall about 25 ft. high was built against the uphill side of the structure. Gravel was then sluiced into the voids.



REINFORCING IN DITCH WIRED TO RODS ANCHORED IN ORIGINAL FLOOR



USING SMALL MOUNTED DERRICK IN CONSTRUCTING PIPE SECTIONS

Concrete Pipe for Subaqueous Tunnels

Construction Methods for Building Sections Nine Feet in Diameter—Detailed Costs for Labor, Material and Equipment

By J. C. LATHROP

Civil Engineer, Consolidated Gas, Electric Light & Power Company, Baltimore

DURING the construction of an addition to the Westport Power Station of the Consolidated Gas, Electric Light & Power Company, of Baltimore, which is located on an arm of the Patapsco River, it was necessary to build new intake and discharge tunnels for condensing water.

The portions under the building were constructed in earth and the work was comparatively simple, being included in the building contract. The inside cross-section of each tunnel is 10 x 12 ft., making a net area of 120 sq. ft. The remaining parts of the tunnels, which are about 240 ft. long, extend into the river, where the water averages from 2 to 10 ft. in depth. The bottom, of hard sand, is covered with a layer of mud and silt 20 or 30 ft. thick.

DESIGN

Owing to the depth of the river portion of the intake tunnel, great difficulty was anticipated if an attempt were made to build a cofferdam and unwater the site. Another important consideration was that at some future date the company would fill over these tunnels and store coal to a depth of probably 16 ft. For this reason circular tunnels were desirable, and the two types of design and construction described below were considered, either type to be placed on pile bents. These bents are shown on the cross-section and consist of two 12-in. piles capped with 12 x 12-in. yellow-pine timbers.

The first design contemplated two steel tubes of 9 ft. internal diameter for each tunnel, which would be built in a local shipyard. These tubes were to be covered with a 6-in. layer of concrete heavily reinforced.

Bulkheads were to be placed in each end, and the tubes, which would be built on a marine railway, could be launched and towed to the site, where they would be sunk to their final positions and adjusted by divers.

The second design called for the construction on the company's property of reinforced-concrete pipe in sections 15 ft. long, with an internal diameter of 9 ft. A wooden cradle was then to be fastened to each section and they were to be lifted by a floating derrick and placed on the pile bents. This operation was to be directed and the joints calked with oakum by divers.

The latter design was adopted, as the bids received for the entire work ran very much lower than those for the first scheme.

CONSTRUCTION

An interesting feature of the work was the actual construction of the pipe sections, and this article will cover the methods and costs of this portion of the work. A contract was made with the Lock Joint Pipe Company, of New York, to build twenty-nine pipe sections only, as the entire intake and discharge tunnel system is designed for a future capacity of 105,000 kw, and only 22,500 kw will be installed at this time. The pipe sections exceed in both diameter and length any similar pipes ever made prior to this year, although, curiously enough, the contractor has a contract with the city of Baltimore to build a mile or more of pipe of the same internal diameter, the sections, however, being only 6 ft. long.

The contract calls for the delivery of these pipes laid on their sides on wooden skids,

so that they can be readily rolled to the water's edge. A section of the company's property was leveled and the pipes were built in two rows, as shown in one of the photographs.

The pipe detail is shown on the drawing. The total area inside two pipes is 127.2 sq. ft., or a trifle more than that of the single rectangular tunnel under the building. Each section contains 12.6 cu. yd. of concrete and weighs 26 tons. The concrete is somewhat richer than 1 part of cement, 2 parts of sand and 4 of gravel. The gravel varies from $\frac{1}{2}$ to $1\frac{1}{2}$ in. in size. The circular reinforcement around each section consists of two layers of A. S. & W. rectangular mesh, made of three $\frac{3}{16}$ -in. round bars on 4-in. centers. The longitudinal reinforcement consists of thirty-four $\frac{1}{2}$ -in. Have-meyer bars.

CAST-IRON BASES

Six cast-iron bases were furnished, to which were attached inner and outer steel forms, two sets being provided. The inner form was placed first and the reinforcing material erected around it, after which the outer form was placed, the surface to come in contact with concrete being well oiled. The concrete for this work was mixed thoroughly and was hoisted to a mixing board placed on the top of each section of pipe and shoveled into the form. It was then carefully and thoroughly spaded down. The photographs show the very smooth exterior produced.

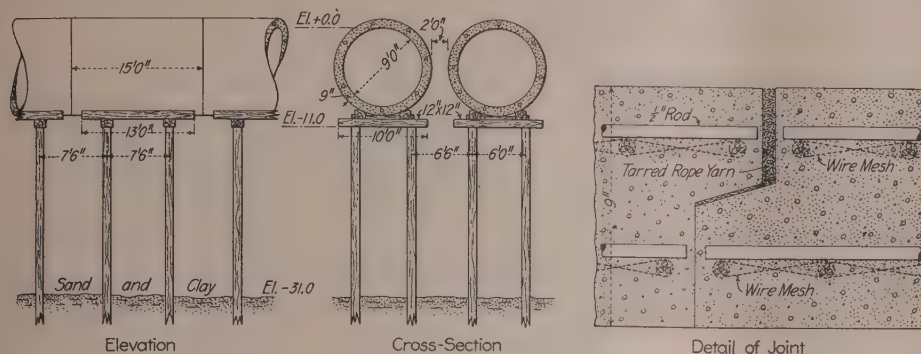
This work proceeded rapidly after the preliminary work was done and actual pouring of concrete started. One or two of these pipes were poured each day, live steam being admitted to the inside of the pipe for about 12 hr. At the end of this time they were sufficiently cured to permit removal of the forms, allowing work to proceed on the next set.

It will be noted that only six base castings were used on this job during the construction of twenty-nine sections of pipe.

A simple but effective method was used in removing these bases from beneath the pipe sections. A 12 x $\frac{3}{8}$ -in. steel band, in four sections, to which were riveted four pairs of 6 x 6 x $\frac{3}{8}$ -in. angles was placed around the pipe about 5 ft. above the ground. Underneath these angles, which formed inverted seats, were placed heavy timbers, which in turn rested upon four jacks. It was found that the pipe could be lifted clear of the cast-iron bases within



REMOVING CAST-IRON BASE FROM PIPE



ELEVATION AND CROSS-SECTION OF PIPES AND DETAIL OF JOINT

48 hr. after being poured without injury to the pipe.

Several sections were cast with 36-in. manholes in the sides, to allow entrance when it became necessary to clean the tunnels.

Most of the equipment used is shown in one of the photographs.

The small stiffleg derrick, with engine mounted on a platform and so arranged that

the complete equipment could be skidded along, was used for a great variety of purposes, including handling and placing forms, lifting skips of concrete to the top of the form, handling and placing reinforcing material, etc. Two "Little Wonder" gasoline-engine-driven concrete mixers were used and proved very satisfactory for this class of work.

COST

The total cost of manufacturing the twenty-nine sections of pipe, prepared from force accounts and bills of material, is given in the table.

The method used in turning these pipes on their sides, as well as placing them under water, will be described in a future article.

Street Repairs in Chicago

Costs for Mending 450 Miles of Pavement with Municipal Equipment

ASPHALTIC concrete used for topping old macadam streets and roads in the outskirts of Chicago is made under city supervision in a railroad portable plant now located at Vincennes Avenue and Ninety-fifth Street. It is of the Warren type, cost \$15,000 and can turn out material to pave 2500 sq. yd. of 2-in. top in a 9-hr. day, which is the equivalent of 27 mi. of 18-ft. country road in a working season. The photograph shows the plant furnishing material for a cross-connection on Ninety-fifth Street between two north-and-south arteries, Western Avenue and Cottage Grove Avenue. The former street has also been topped for sev-

eral miles from the same plant. It is the longest street in the city and part of the principal connection between the boulevard system of the city and the Lincoln Highway at Chicago Heights. A State-aid road will complete the connection outside of the city limits. Topping old macadam roads can be done, according to Walter Leineger, superintendent of streets, at 60 cents per square yard. The estimated life, without repairs, is five years, and with reasonable repairs twenty years. Country roads have cost about 20 cents per yard per year to maintain, and the condition is not satisfactory at that. There are 500 mi. of macadam streets in Chicago that can be treated with topping.

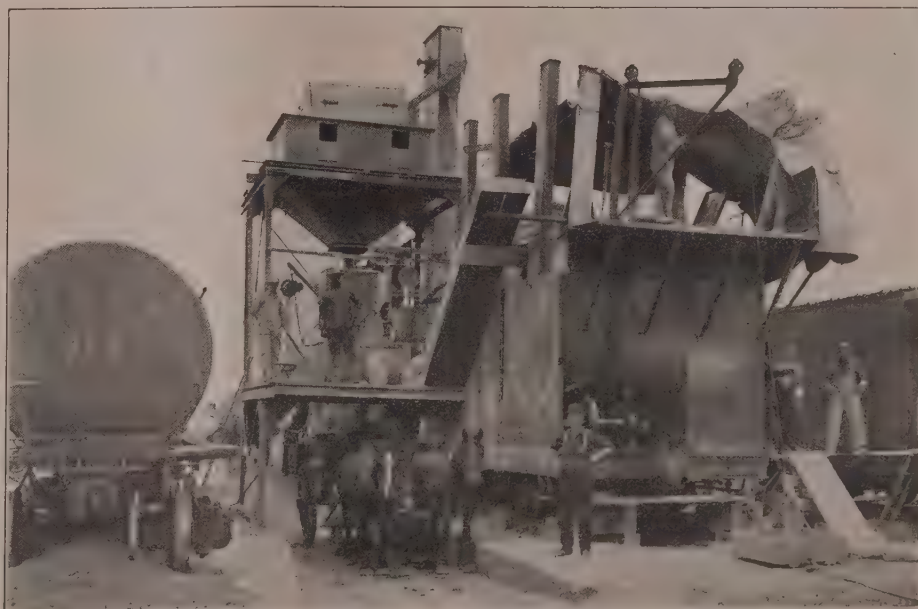
Besides the railroad plant the city owns a stationary plant having sufficient capacity to turn out daily material for 2000 sq. yd. of finished asphalt pavement, a second portable plant for utilizing old asphalt for repair work, ten 10-ton three-wheel rollers, five 5-ton and two 10-ton tandem rollers, twenty asphalt wagons, four portable boilers, four scarifiers, and three auto trucks. Each winter the equipment is overhauled to prevent breakdowns in the working season.

Work of the repair forces is so organized that a great proportion is done early in the season, so that traffic will have the benefit of the repairs the same year. About \$450,000 has been spent since Jan. 1 last. Costs per square yard are: 89,123 sq. yd. of asphalt, 95 cents; 30,440 sq. yd. of brick, \$1.06; 30,900 sq. yd. of granite, 55 cents, and 376,960 sq. yd. of macadam, 20 cents. In mileage the repairs so far this year are: Asphalt, 100; brick, 35; granite, 10; macadam, 300, and asphaltic concrete, 5.

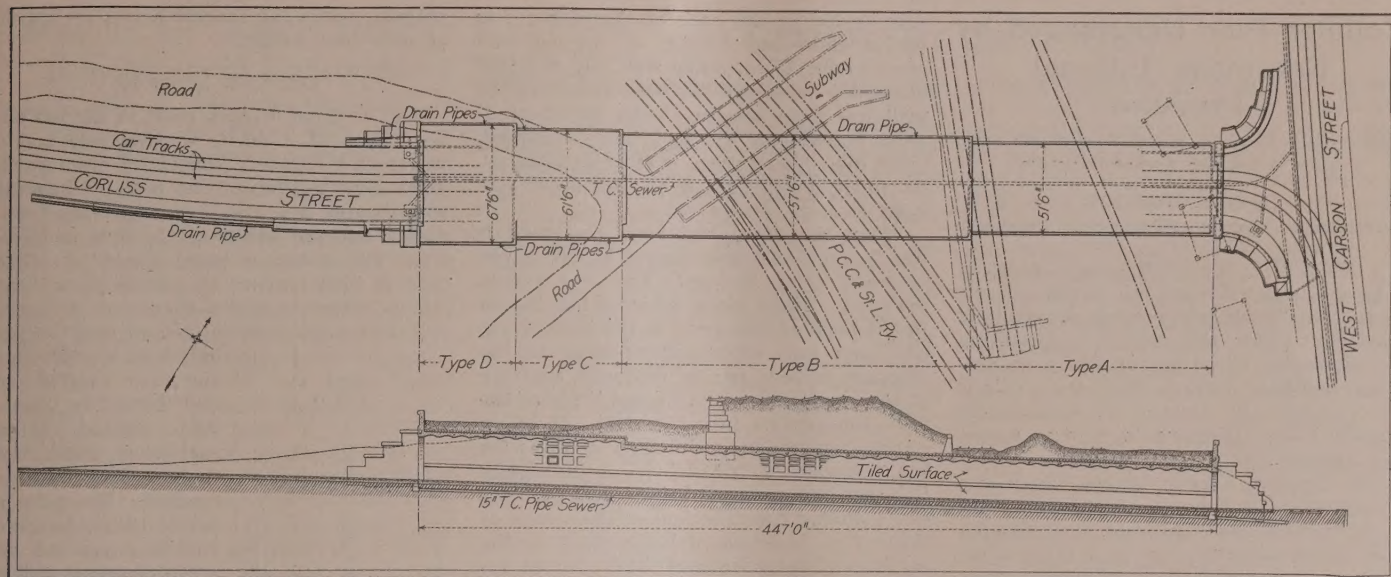
IRRIGATED LAND in British Columbia is estimated by engineers of the water-rights department in that province to total 69,832 acres in the more settled valleys south of the railway belt, while an additional 740,000 acres in the same valleys could be brought under irrigation. Although these estimates refer to the choicest sections of the province, the report states that other large areas can be economically considered for irrigation when transportation facilities improve.

TOTAL COST OF MANUFACTURING TWENTY-NINE SECTIONS OF PIPE

Labor		Cost per linear ft. of pipe
Grading yard and building cement shed, March 16 to 27, inclusive:		
Foreman, 9½ days, at \$5.00.....	\$47.50	
Laborers, 275 hr., at 17½.....	43.13	
Team, 8 hr., at .50.....	4.00	
	\$99.63	\$0.23
Preliminary work, including erecting two sets of forms, April 20 to 25, inclusive:		
Supt., 5½ days at \$10.00.....	\$55.00	
Foreman, 5½ days, at 5.00.....	27.50	
Engineer, 5 days, at 5.00.....	25.00	
Laborers, 385 hr., at 17½.....	67.38	
	\$174.88	\$0.402
Setting and removing forms, pouring concrete and lifting pipe, April 27 to May 23 inclusive:		
Supt., 4 days, at \$10.00.....	\$40.00	
Foreman, 27 days, at 5.00.....	135.00	
Engineer, 25 days, at 5.00.....	125.00	
Laborers, 4054 hr., at 17½.....	709.45	
Carts, 23 hr., at .30.....	6.90	
Teams, 13 hr., at .50.....	6.50	
	\$1,022.85	\$2.351
Lifting pipe and removing six bases, clearing up and moving plant, May 25 to 27, inclusive:		
Foreman, 3 days, at \$5.00.....	\$15.00	
Engineer, 2 days, at 5.00.....	10.00	
Laborers, 234 hr., at 17½.....	42.53	
	\$67.53	
Total for labor.....	\$1,364.89	\$3.14
Material		
Cement, 625 bbls., at \$1.28.....	\$800.00	
Sand, 221 cu. yd., at \$0.45.....	99.45	
Gravel, 365.0 cu. yd., at \$0.95.....	346.75	
Hauling sand and gravel from barges to stock pile.....	106.06	
9,900 lb. ½-round bars, at \$1.4.....	138.60	
27,800 lb. wire mesh.....	444.80	
2 sets of steel forms (33,700-lb.), at \$0.05.....	1,685.00	
Lifting collar, 600 lb., at \$0.05.....	30.00	
Cement shed.....	25.00	
Total for material.....	\$3,675.66	\$8.45
Equipment		
Rental or depreciation—		
Derricks, 38 days, at \$5.00.....	\$190.00	
2 concrete mixers, 38 days, at 2.00.....	76.00	
2 skips, 38 days, at 1.00.....	38.00	
6 C. I. bases, 38 days, at 1.00.....	38.00	
Wheelbarrows, shovels and mi- nor equipment, 38 days, at 1.00.....	38.00	
	\$380.00	\$0.874
Summary		
Labor and field supervision.....	\$1,364.89	\$3.14
Material.....	3,675.66	8.45
Rental or depreciation of equipment.....	380.00	.874
	\$5,420.55	\$12.464
Contingencies, 10 per cent.....	542.06	1.246
	\$5,962.61	\$13.710
Overhead, office expenses, etc., 10 per cent.	\$596.26	\$1.37
Total cost.....	\$6,558.87	\$14.08



MUNICIPAL PORTABLE ASPHALT PLANT AT NINETY-FIFTH STREET, CHICAGO



PLAN AND PROFILE OF CORLISS STREET TUNNEL WITH LOCATION OF DIFFERENT TYPES OF CONSTRUCTION

the horizontal thrust of the arch, thereby reducing the amount of concrete necessary for the footings of the side walls. The side walls are made very heavy, as the poor rock extends up along to the springing line, and the construction joint with the roof arch is made at an angle of 45 deg. with the horizontal. The remaining 51 ft. of tunnel lining at the other portal are of type D. Very thick side walls and abutments are necessary to transfer the thrust line of the arch to strata of sufficient abutting power to resist it. The extrados is tangent with the battered rear face of the side walls and the construction joint is normal to the thrust line of the arch.

RETAINING WALLS

The open-cut approach is excavated on a sidehill, where the high earth bank is retained by concrete walls of the reinforced and plain types. These walls have a maximum height of 31 ft., and are built in sections from 25 to 30 ft. long, separated by vertical transverse construction joints with keys 6 in. thick in the lower part. The counterfort walls have an extended base $8\frac{1}{2}$ to $14\frac{1}{2}$ ft. wide and 24 in. thick, engaging the bottoms of the counterforts from 12 to 24 in. wide. The walls and base are heavily reinforced by horizontal bars, which, in the face of the wall, are spaced by vertical angles slotted to receive them. The counterforts are reinforced with heavy bars along their back surface and

carry the vertical U-bond bars of the floor slab and the horizontal U-bond bars of the curtain wall.

The work was designed and executed under the direction of the bureau of construction, Department of Public Works of the city of Pittsburgh, of which N. S. Sprague is superintendent and T. J. Wilkerson division engineer in charge of this work, assisted by John D. Stevenson, assistant engineer. The contract was awarded to the M. O'Herron Company for \$179,681.20, unit prices on estimated quantities.

Partial Estimates

Short-Cut Method of Calculation Used by Chicago Board of Local Improvements

MULTIPLES of \$50 or \$100 are paid to contractors in estimates made up by engineers of the Chicago Board of Local Improvements. As 15 per cent is retained by the city, 100 per cent is an uneven figure. The method by which this exact total sum is obtained is described by A. J. Schafmayer in a recent thesis presented to the University of Illinois.

For many years the gross amounts equivalent to an 85-per cent net for amounts ranging from 100 to 1000 had been worked out and listed for multiples of 100. Additional amounts corresponding to multiples of 1000 up to 10,000 were also listed. Thus

by a process of addition the amounts corresponding to other multiples of 100 could easily be obtained. It was observed that these gross amounts invariably terminated in a repeating decimal. After experimenting with many combinations and making extensive computations, J. G. Gabelman, assistant chief engineer of streets, devised a table, part of which is shown herewith. This table shows immediately the gross amount or 100 per cent for multiples of 50 when considered as 85 per cent. The method of using the table consists of finding the net figure in the body of the table, and then obtaining the first digits of the gross amount, which are shown at the tops of the corresponding columns. These figures are called "characteristics" in the table from their resemblance to the characteristics of logarithms. The remaining digits of the gross amount are found by reading the figures on the same horizontal line in the column at the extreme right, headed "Mantissæ." This name was also given because of a certain similarity to the mantissæ of logarithms. The reverse operation is often used also, in which, by selecting the gross amount next below the gross amount actually completed, the corresponding net amount due is quickly obtained.

This table has proved very convenient as a labor-saving device in the preparation of the large number of partial estimates that are issued in the course of the construction period.

TABLE FOR COMPUTING PARTIAL PAYMENT TO CONTRACTORS

CHARACTERISTICS																MANTISSÆ
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
0	850	1700	2550	3400	4250	5100	5950	6800	7650	8500	9350	10200	11050	11900	12750	000.000000
50	900	1750	2600	3450	4300	5150	6000	6850	7700	8550	9400	10250	11100	11950	12800	058.823529
100	950	1800	2650	3500	4350	5200	6050	6900	7750	8600	9450	10300	11150	12000	12850	117.647058
150	1000	1850	2700	3550	4400	5250	6100	6950	7800	8650	9500	10350	11200	12050	12900	176.470588
200	1050	1900	2750	3600	4450	5300	6150	7000	7850	8700	9550	10400	11250	12100	12950	235.294117
250	1100	1950	2800	3650	4500	5350	6200	7050	7900	8750	9600	10450	11300	12150	13000	294.117647
300	1150	2000	2850	3700	4550	5400	6250	7100	7950	8800	9650	10500	11350	12200	13050	352.941176
350	1200	2050	2900	3750	4600	5450	6300	7150	8000	8850	9700	10550	11400	12250	13100	411.764705
400	1250	2100	2950	3800	4650	5500	6350	7200	8050	8900	9750	10600	11450	12300	13150	470.588235
450	1300	2150	3000	3850	4700	5550	6400	7250	8100	8950	9800	10650	11500	12350	13200	529.411764
500	1350	2200	3050	3900	4750	5600	6450	7300	8150	9000	9850	10700	11550	12400	13250	588.235294
550	1400	2250	3100	3950	4800	5650	6500	7350	8200	9050	9900	10750	11600	12450	13300	647.058823
600	1450	2300	3150	4000	4850	5700	6550	7400	8250	9100	9950	10800	11650	12500	13350	705.882352
650	1500	2350	3200	4050	4900	5750	6600	7450	8300	9150	10000	10850	11700	12550	13400	764.705882
700	1550	2400	3250	4100	4950	5800	6650	7500	8350	9200	10050	10900	11750	12600	13450	823.529411
750	1600	2450	3300	4150	5000	5850	6700	7550	8400	9250	10100	10950	11800	12650	13500	882.352941
800	1650	2500	3350	4200	5050	5900	6750	7600	8450	9300	10150	11000	11850	12700	13550	941.176470

Cellular Pier Undamaged by Enormous Internal Pressure

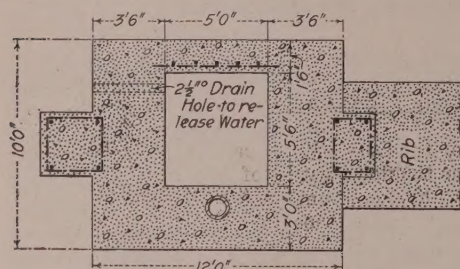
Seventy-Foot Head of Water Successfully withstood in Larimer Avenue Structure

By N. S. SPRAGUE

Superintendent, Bureau of Engineering, Pittsburgh

RECENTLY one of the main piers of the Larimer Avenue reinforced-concrete bridge in Pittsburgh became accidentally filled with water, this condition presenting an interesting situation for which no provision had been made in the design. While not resulting in damage, it undoubtedly subjected the structure to a very severe and unusual test.

The Larimer Avenue bridge, which was completed in 1912, has a main span of 312 ft. carried by two reinforced-concrete arch ribs. The roadway over each main abutment is supported by two cellular concrete



HORIZONTAL SECTION OF CELLULAR PIER

piers, rectangular in section, and without reinforcement except on one side. The curb of bridge is 76.81 ft. above the skewbacks of the main arch ribs, and the supporting piers are hollow from the top of the skewback to within 14 ft. 6 in. of the curb, the cellular space thus being slightly more than 62 ft. in height. These piers, above the skewbacks, are 10 ft. in width, measured transversely to the longitudinal center line of the bridge, and 12 ft. in length. The front and back walls are 3 ft. 6 in. in thickness, while one side wall is 3 ft. and the other 18 in. thick. Only the 18-in. side wall is reinforced, this having 1/2-in. square twisted rods spaced 12 in. both vertically and horizontally, the rods being placed close to the inner surface.

At the main arch abutment there is a catchbasin at each side of the roadway, the drainage from which is carried in a 12-in. cast-iron pipe embedded in one of the walls of the hollow piers. A 6-in. connection is provided at the bottom of the cells, these having been placed to drain off any water which might enter the cellular spaces. Below the ground surface the drains are connected to a sewer.

HEAD OF 70 FEET IN CELLULAR SPACE

During July of the present year the writer in passing noticed slight discolorations in a few places and also evidences of moisture near the top of the southerly pier at the eastern end of the bridge. An investigation was at once ordered and it was discovered that the pier was entirely filled with water, as was also the drain pipe, to within about 6 ft. of the curb. This showed that there was a head of practically 70 ft. on the pier at its base. Steps were taken at once to draw off the water, the excavation of the drain beyond the pier and the drilling of a hole in the side wall of the pier being begun simultaneously. A 2 1/2-in. hole

was drilled in the back of the pier a few inches above the bottom of the cell and close to the 18-in. outer wall. It required about 3 1/2 hr. to drill the hole, and when the wall had been punctured the water gradually flowed out, the flow being retarded, since the cellular space is entirely filled up. At the end of about 8 hr. the water had been entirely drawn off.

When the drain had been excavated it was found that it was clogged by two pieces of wood 18 in. in length and of 1 x 4-in. material. These pieces of wood had lodged in the bend of the drain at the base of the pier and had effectually resulted in the stoppage of flow, and the drainage, entering at the catchbasins, had backed through the 6-in. connections into the cells. It is, of course, impossible to definitely account for the presence of the debris in the drain. Possibly the pieces of wood fell into the drain during construction, or the screen of three 1-in. bars placed horizontally at the catchbasin entrance may have proved ineffectual. As a precaution an additional and closer screen is being placed at the catchbasins. Also, to guard against similar accidents, holes are being drilled in the other piers to prevent an accumulation of water in the cells in case the drains should again become clogged. Manholes are also being constructed to permit of the inspection of the drains.

The pressure which the side walls of the piers withstood at their base amounted to slightly more than 30 lb. per square inch, this giving a total load of more than 21,000 lb. on a strip of the 18-in. wall 1 ft. in height. The result of this test would seem to demonstrate the integrity of the work and the ability of this and similar construction to withstand unusual and unforeseen contingencies.

High Wireless Masts Built Up in Place with Steel Sections

Ten-Foot Metal Cylinders, in Halves, Are Bolted to Form 400-Foot Pole

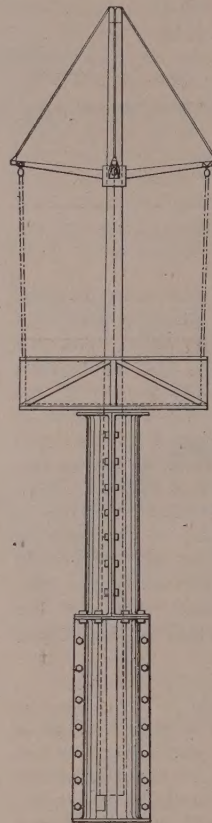
THE Marconi Company now has under construction at Kahuku, the most northerly point of the Island of Oahu, Hawaiian group, a wireless station provided with two aeriels, one directed toward Japan and the other toward San Francisco. These aeriels are being built 5000 and 4000 ft. long respectively and will be hung from steel masts erected in pairs and arranged to support the aeriels much as a trolley wire is supported by poles on opposite sides of a street. There will be more than thirty of these masts altogether and their height for the shorter aerial will be 320 ft., while the longer one will require a mast height of about 400 ft., the exact height in the latter case to be determined later when the station can be tuned up.

The steel sections used to build up the masts are 10 ft. long and were shipped in semi-cylindrical form, designed to be bolted together as the erection proceeds. The diameter of the sections varies at different heights, being 24 in. at the top, however, for all masts. The 400-ft. masts have a base diameter of 42 in. and a metal thickness of 1/2 in., while the shorter ones which are made of 3/8-in. metal, are 30 in. through at the base and maintain this diameter to a height of 170 ft. The taller masts are guyed in four directions at six different

heights, while the shorter masts are guyed at only four heights.

ERECTION METHODS

The erection of each mast is carried out by means of a 40-ft. wooden pole and a workmen's "basket" suspended from yardarms near the top of the pole. When the work begins this pole is set up on the foundation and the halves of the first two sections are bolted in place around it. The pole is then raised by means of a rope which passes around a sheave at its lower end, and when fixed in its new position the



WIRELESS MAST

halves of another section are hoisted up and bolted in place, this method being continued until the desired height is reached. The pole is raised 10 ft. at a time and is supported on a bar inserted below the bottom of the pole in the rectangular holes shown in the illustration. A diaphragm is bolted in between each pair of sections and is provided with a central hole 14 in. square. The wooden pole just fits inside these 14-in. holes and is thus steadied at two points in its 20-ft. length inside the mast. When ready for a new section to be hoisted up, 20 ft. of the pole project above the steel-work, and midway of this distance a collar carrying four struts or yardarms is fixed to the pole. The workmen's "basket" is suspended from these struts by means of a tackle, which

allows it to be moved up and down enough to give convenient access to all parts of the new sections as they are bolted in place.

Each mast is founded in a separate block of concrete in which a heavy casting is embedded to afford an anchorage for the first section. Throughout the height of the pole adjoining sections have their vertical flanges in planes at right angles, so that joints are staggered all the way up the mast. When the final height of steelwork for each mast has been attained, the pole used in erection is to be fastened with 30 ft. of its length projecting above the top section and left thus as a permanent part of the mast.

In addition to the erection of the masts for the aeriels, the work at Kahuku includes the building of a steel-frame steam-electric plant, a boiler house with a tall brick stack and other buildings. On Feb. 1 the stack had been completed, the boilers were in place and most of the steelwork for the buildings had been erected. Work was also in progress on several of the masts, two of which had been carried to a height of 170 ft. The contract for the construction of the plant is held by the J. G. White Engineering Corporation, of New York and London.

Results of Public-Utility Regulation in California

John M. Eshleman, President of Railroad Commission, Discusses Subject Before San Francisco Chamber of Commerce

THE question "Does Regulation Hurt Business?" was discussed by John M. Eshleman, president of the California State Railroad Commission, before the Chamber of Commerce of San Francisco on July 31. Figures were quoted to show that there had been a greater development of public-utility enterprises since the commission was given jurisdiction over stock and bond issues (March 23, 1912) than in any other period in the history of the State.

Up to June 30, 1914, the commission has authorized the issue of \$284,000,000 in securities, Mr. Eshleman said, has denied or dismissed applications for \$32,000,000 and is now considering applications for issues totaling \$82,000,000. For the steam railroads of the State in that period there has been authorized \$126,000,000 of securities; for electric railways, \$41,000,000; for gas and electric companies, \$80,000,000. A total of more than 700 mi. of railway has been undertaken and carried forward under the regulation of the California commission. And this is only a part of the actual development, as the sum for new equipment will approximate \$15,000,000. Gas and electric companies are spending \$80,000,000 under regulation for various projects.

REGULATION AN AID TO FINANCING

The California commission has adopted the principle of protecting a public utility in its field of operation, he said, so long as that utility properly performs its duties to the public. Nearly all the men in control of public utilities regard regulation as an aid in financing new utility projects or the extension of those already established.

On the other hand, rates shown to be discriminatory or unjust have been adjusted to the great benefit of the patrons. Cheaper freight rates and reduced long distance telephone tolls were the advantages cited. The former in some cases were so abnormal as to contribute a positive barrier, he said, to business enterprises. Wells Fargo & Company, for instance, had been reaping annually in California a profit of 136 per cent in the express business. If it was hurting business to reduce that profit to a 10-per cent rate, he believed, then this was a business that ought to be hurt.

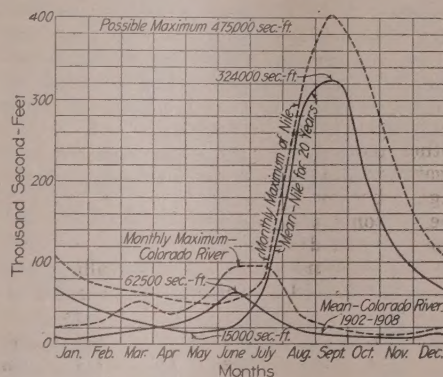
A public utility is monopolistic in its nature, Mr. Eshleman said, as it deals directly with the individual. Alone, the individual is powerless. Simple justice requires that the State provide a tribunal to control the relations between the public utility and the individual patrons. Jurisdiction over public utilities should embrace the regulation of rates, service and finances, he said, and the question is no longer "Does regulation hurt business?" but, "Shall it be regulation or shall it be public ownership?"

INCREASED DEMAND for underground space for utility conduits has made it necessary in Dayton, Ohio, to reserve at least a portion of the sub-sidewalk areaway for municipal use. On Aug. 5 the commissioners voted to sustain a ruling made by H. W. Waite, city manager, to the effect that all areaways must be kept 10 ft. inside of the curbs.

Letters to the Editor

Nile and Colorado Rivers Compared

SIR: The visit of Sir William Willcocks, builder of the Assuan Dam, to this country in connection with the International Drainage Congress at Atlanta and his tour of the Reclamation Service projects have increased the interest in the work with which his name is associated. This gives added interest to a comparison between his work in connection with the building of the Assuan Dam and the control of the Nile for irrigation purposes and the work performed by the Reclamation Service in connection with the control of the Colorado River, sometimes called the Nile of America, the building of the Laguna Dam across this stream and the construction of the irrigation works of the Yuma project in Arizona



FLOW OF NILE AND COLORADO RIVERS

and California. The Nile and the Colorado Rivers have much in common and yet many points of dissimilarity.

Drainage Areas.—The drainage basin of the Nile has an area of approximately 1,262,000 sq. mi. and is located largely in equatorial regions with heavy tropical rainfall. The drainage basin of the Colorado has an area of 229,000 sq. mi. and is located largely in the cold uplands of Colorado and Wyoming, with relatively small rainfall. The former river flows from a hot region to a relatively cooler region, the latter from a cold to a hot.

Delta Areas.—The principal point of similarity is that both rivers in their lower regions pass through desert regions and have formed near their outlets great alluvial deposits, or deltas, the soils of which are as fertile as any in the world. The delta region of the Nile or Lower Egypt has always been densely populated, and is covered with a network of canals. The delta of the Colorado River, on the contrary, is very sparsely settled and most of it is in another country, namely, Mexico, and is thus cut off politically from the country in which the river rises and where only the large storage reservoirs can be built.

Controlling Works.—Before reaching the delta region each river is controlled by a barrage or low dam. That on the Nile, the Assuan, has a length of 6250 ft. and a maximum height of 143.5 ft. above foundation, and forms a storage reservoir having a capacity of about 1,865,000 acre-feet. It is pierced by 180 openings to permit the silt-laden waters of the Blue Nile in time of flood to pass through, and later retain in the reservoir the clear water for irrigation purposes. On the Colorado River the Laguna Dam, which has no openings and is an overflow weir, has a length of 4750 ft.

and a maximum height of only 40 ft., forming a reservoir with an area of only 6400 acres. The result of this design has been, as was intended, that the heavily laden, silty waters deposited their load above the dam, completely filling the reservoir, the purpose of the dam being simply to raise the water sufficiently to divert it into the canals on either bank.

Discharge of Rivers.—The accompanying diagram indicates the most striking points of contrast between the two great rivers. It will be noted that the Nile usually carries four or five times as much water in flood as the Colorado. The floods of the Colorado, caused by melting snows, come in June; those of the Nile occur in September. The low-water flow of the Colorado, it will be noted, is about 3000 to 4000 sec.-ft., while that of the Nile is about 12,000 sec.-ft. The high water of the Colorado averages about 62,500 sec.-ft., while that of the Nile averages 324,000 sec.-ft.

Storage Conditions.—The storage problems on the two rivers are somewhat similar in that the best reservoir sites are near the head waters and many hundreds of miles away from the irrigated fields. In the case of the Colorado the case is perhaps simpler, as the flood waters of May and June have to be held only until July, August and September, while those of the Nile, coming in August and September, must be held over until the following summer.

W. I. SWANTON,
Assistant Engineer, U. S. Reclamation
Service,
Washington, D. C.

A System of Duplicate Reservoir Outlets for Earth Dams

SIR: The most frequent cause of recent failures of earth dams has been defective outlet arrangements. These failures, which have been so numerous, have shown that an additional provision should be made to the outlet arrangements now in vogue.

An outlet arrangement to a long earth dam in Colorado which was created from the necessity of controlling a defective fill offers an excellent provision for outlets to any long earth dam. In this example excessive seepage through the fill close to the location of the outlet conduit began soon after the dam was completed. This seepage increased to such an extent that a secondary dam in the form of a loop was made to inclose the defective portion of the fill and the outlet conduit, similar to the manner of inclosing sand boils which are frequently found on levee work. The secondary dam or loop is formed in the shape of a U, with the ends joining the main dam, and in the crown of the loop a duplicate outlet arrangement is provided which heads the outlet canal and duplicates the outlet in the main dam.

With this design of an outlet the reservoir water is under control by two sets of gates which are segregated by an intervening balancing reservoir. The primary and secondary outlets are so disassociated from each other that they are under independent control, a feature not always practically attained when duplicate gates are installed in the same fill. To provide a variation of water pressures upon either gate requires a certain independence between the gates, which the intervening balancing reservoir

very well provides. Due to the fact that the portion of the main dam between both reservoirs is under a double saturation it is necessary that the junctions of the fill of the secondary and main dams should be well formed.

The added cost of a duplication of the outlets over a single arrangement is insignificant in comparison to the total cost of a long dam and the additional insurance secured. From the number of earth dams which have recently failed due to defective outlets it is apparent that proper construction rather than first cost should be given greater consideration.

NEWTON L. HALL,
Of the Ambursen Company.

Denver.

Hauenstein Tunnel in Switzerland Holed Through

SIR: Your readers may be interested to know that the 26,683-ft. double-track Hauenstein tunnel driven through the Jura Mountains in Switzerland was holed through July 10, after twenty-nine months' work—eighteen months in advance of the time specified by the contract.

The materials penetrated were chiefly

cannot be told. Judging from the senses of the passenger, the impact on the asphalt pavement is so much greater that the oiled macadam may easily outlast the other. These observations were made under maximum-speed conditions of 17 mi. per hour.

Los Angeles. GEO. L. DAVENPORT, JR.

Cost of Preparing New York City Contracts

SIR: In his comments in the issue of July 11, page 57, on my letter relative to the cost of preparing New York City contracts (printed in the issue of June 20, page 713) Charles I. Dingman shows that he has not fully understood my meaning. The example of standardized specifications that he quotes is as far from what I suggested as the present New York practice is. I fully agree with him that the binding together of a lot of loose standard specification sheets is poor practice. My plan was much simpler and called for a bound volume of standard specifications covering all materials and nearly all classes of work that the city might require.

The reference to these specifications was to be by paragraph number only, and nearly

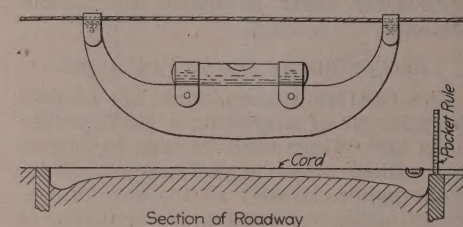
conditions of many concrete sidewalks, crossings and curbs. These forces are the vibration of the soil arising from the traffic in the streets and roads, the expansion and contraction of the soil on the earth, under the sidewalks and crossings, brought on through the rain and sun, and the fact that the slab of concrete is made too thin to stand its own weight and the traffic when unsupported, owing to this contraction of the soil.

I do not agree with Mr. Berg as to the advisability of putting in some kind of reinforcement in slabs used as sidewalks, crossings and curbs, for the reason that these slabs are generally used too thin, and if the reinforcement is not embedded on all sides at least 1½ in. its expansion will split the concrete when subjected to the sun or other heat. Therefore the slabs should have a thickness of at least 5 in.

JUAN I. DE JONGH, C. E.,
Consulting Engineer and Architect.
Guatemala.

Pocket Level for Short Distances

SIR: A handy little pocket level for use on short distances where great accuracy is not required is shown in the accompanying sketch. It is made of aluminum, is 5 in. long and weighs half an ounce. In use the level is hooked over a cord, preferably a hard-twisted or braided fish line, of sufficient strength to bear being pulled taut



POCKET LEVEL AND ITS USE ON CURB WORK

without breaking. The cord is stretched between the two points whose difference of elevation is wanted and the difference measured with a pocket ruler. On distances of 10 ft. the level is sensitive to ¼ in. and at 30 ft. it will show differences of elevation of ¼ in.

The writer designed the device, which is not patented. There are many situations where such an instrument will be found extremely useful and will serve as well as the regular engineer's level.

THOMAS C. HARRIS,
United Railways & Electric Company.
Baltimore.

shale, limestone, anhydrite and marl. As much as 45 ft. of heading were driven per 24 hr., and the driving progress for twelve consecutive months was 750 ft. The average progress for twenty-nine months was 721.6 ft. (all figures for one heading). The table gives an idea of the progress made during the year 1913. A cross-section of this bore was shown in the Engineering Record of Nov. 8, 1913, page 510.

EUGENE LAUHLI,
Civil and Hydraulic Engineer.
Tallulah Falls, Ga.

Asphalt and Oiled Macadam Pavements

SIR: Recently a line of motor omnibuses has been placed in service between Los Angeles and Venice, Cal., a beach resort about 15 mi. distant. The buses are double-decked, seat 54 people, and are mounted on a 5-ton chassis. Probably the weight loaded is about 9 tons. For a third of the trip the street is paved with asphalt on a 5-in. concrete base, the total thickness being 8 in. The rest of the route is over an oiled-macadam county road of approximately the same thickness. To the eye the asphalt pavement is much the better, but the omnibus rides easier on the oiled macadam. The small waves in the asphalt surface cause a somewhat disagreeable vibration which the longer waves in the macadam do not produce. Which pavement will last the longer under the heavy traffic—on 7 min. headway during rush hours—

any contract could be covered by a few pages giving the paragraph numbers governing the work and such possible exceptions as it might be deemed wise to make. This presupposes full detail plans, and if no other good were to result from the use of this form of specification than to make the designers furnish full and complete details of the work to be done, on their plans, it would be worth while to give the system a trial. As a matter of fact the contractors would be fully as much benefited by such standard specifications as would the city.

That the system will work I know from actual experience, gained many years ago in foreign railroad service, where I had the privilege of seeing Government work well done in spite of the inevitable "Government" red tape.

B. M. WAGNER.
Rockville Center, N. Y.

Curb Failures at Concrete Crossings

SIR: The interesting article written by John Berg in your issue of June 27, 1914, page 729, on the subject of "Curb Failures at Concrete Crossings" prompts me to call the attention of those concerned with the subject to a theory of mine, confirmed by many years of practical observations and results. There are three forces of which no notice seems to have been taken by the profession, and which seem to me to be the chief reasons for the failures or damaged

RAINFALL on the Wachusett watershed of the metropolitan waterworks of Boston during the year 1913 was 41.22 in. and on the Sudbury watershed 44.31 in. On both watersheds the rainfall was below the average of past years, but more than during the previous three years on the Wachusett watershed and the previous five years on the Sudbury watershed. Notwithstanding the larger rainfall, the yield, or quantity collected, on these watersheds was slightly less than in 1912, being 879,000 gal. per square mile per day on the Wachusett watershed and 733,000 gal. per square mile per day on the Sudbury watershed. These are the figures given by Dexter Brackett, chief engineer, in his annual report for 1913.